

**The National Library of Medicine**  
**Index Mechanization Project**







# The National Library of Medicine

## Index Mechanization Project

*July 1, 1958–June 30, 1960*

COUNCIL ON LIBRARY RESOURCES, INC.  
GRANT NO. 28

NATIONAL LIBRARY OF MEDICINE  
Washington, D. C.  
1961



# BULLETIN *of the* MEDICAL LIBRARY ASSOCIATION

---

## THE NATIONAL LIBRARY OF MEDICINE INDEX MECHANIZATION PROJECT

ASSOCIATE INVESTIGATOR      EDWARD A. MILLER  
*Assistant Chief, Index Division*

### TECHNICAL ASSISTANTS

Katharine M. Ahlbers	Maxine E. Kennedy	John E. Smith
Gertrude M. Butler	Laura A. Kovach	Harold L. Tarpley
Arthur Mae Carthorne	Doris M. Langston	Marie Q. Thompson
Thelma G. Charen	Christine W. Robinzine	Mamie O. Toler
Eugene N. Fry	A. Rudolph Sand	Lillian H. Washington
Constantine J. Gillespie	Yvonne B. Scott	Lloyd L. Wommack

### ADVISORY COMMITTEE

Mr. Howard A. Ball	Dr. Sanford V. Larkey	Dr. I. A. Warheit
Mr. Henry J. Dubester	Mr. John Vance	

---

Opinions expressed here are those of the authors and do not necessarily represent  
those of the Association.

*Copyright, Medical Library Association, 1961*

### EDITORIAL BOARD

MRS. MILDRED CROWE LANGNER  
Jackson Memorial Library  
University of Miami School of Medicine  
1000 N.W. 17th Street  
Miami 36, Fla.  
*Editor*

MR. G. S. T. CAVANAGH  
Clendening Medical Library  
Kansas City 12, Kansas  
*Chairman, Publication Committee*

MRS. JACQUELINE W. FELTER  
Medical Society of the County of Queens, Inc.  
112-25 Queens Blvd.  
Forest Hills 75, N. Y.  
*Associate Editor*

DR. DAVID A. KRONICK  
Cleveland Medical Library  
11000 Euclid Avenue  
Cleveland 6, Ohio  
*Business Manager*

MR. FREDERICK D. BRYANT  
J. Hillis Miller Health Center Library  
University of Florida  
Gainesville, Florida  
*Assistant Business Manager*

# EXECUTIVE OFFICERS

President.....	Mr. Robert T. Lentz Jefferson Medical College Library 1025 Walnut Street Philadelphia 7, Pennsylvania
Vice-President (President-Elect).....	Miss Gertrude L. Annan New York Academy of Medicine 2 East 103rd Street New York 29, New York
Honorary Vice-President.....	Willard F. Goff, M.D. 432 Stimson Building 1215 Fourth Avenue Seattle 1, Washington
Secretary.....	Miss Ruth J. Mann Mayo Clinic Library 200 First Street, S.W. Rochester, Minnesota
Treasurer.....	Mr. John P. Isché Louisiana State University College of Medicine 1542 Tulane Avenue New Orleans 12, Louisiana
Past President.....	Miss Mildred Jordan A. W. Calhoun Medical Library Woodruff Research Building Emory University Atlanta 22, Georgia

## BOARD OF DIRECTORS

The Foregoing Officers and the Following Elected Members:

Mrs. Mollie Sittner (1 year)	Mrs. Bernice M. Hetzner (2 years)
Mr. Gilbert J. Clausman (2 years)	Miss M. Irene Jones (3 years)
Miss Helen Crawford (3 years)	

### MEMBERSHIP COMMITTEE CHAIRMAN

Mr. Alfred N. Brandon  
University of Kentucky  
Medical Center Library  
Lexington, Kentucky

### ARCHIVES CURATOR & RESIDENT AGENT

Miss Louise D. C. King  
Medical & Chirurgical Faculty of the  
State of Maryland Library  
1211 Cathedral Street  
Baltimore 1, Maryland

### PLACEMENT ADVISOR

Miss Muriel Hodge  
College of Physicians  
of Philadelphia Library  
19 South 22nd Street  
Philadelphia 3, Pennsylvania

### REGIONAL GROUP LIAISON OFFICER

Miss Otilia Goode  
American Dental Association Library  
222 East Superior Street  
Chicago 11, Illinois

### EXCHANGE MANAGER

Mr. Gilbert J. Clausman  
New York University Medical Center  
550 First Avenue  
New York 16, New York

## *Preface*

A project such as this one cannot be in existence for more than two years without involving a great many people in various depths of participation. Nor does it start out and continue operating very long before it begins to amass a tremendous debt to a host of predecessors who have added to the pool of information to which it is hoped this report will make its own small contribution. The list would be endless, but perhaps the names of those who have been most closely associated with the project may be cited here.

Without the generosity of the Council on Library Resources the project would not have been possible; the continuing encouragement and patience of Mr. Verner W. Clapp and Mr. Melville J. Ruggles of that organization were very helpful.

In the fashioning of the new *Index Medicus* publication system the project was privileged to have at its disposal the talents of Mr. Eugene Garfield, Director of the Institute for Scientific Information in Philadelphia, and Mr. Robert L. Hayne, whose services were made available to the National Library of Medicine through the generosity of his organization, the Smith, Kline and French Laboratories, also of Philadelphia. Mr. Garfield's previous participation in the Welch Medical Library Indexing Project, particularly his work on "The Preparation of Printed Indexes by Automatic Punched-Card Equipment" (March 1953), and Mr. Hayne's background as a former member of the NLM staff provided direct connections to the project which were put to good use.

Dr. Mortimer Taube of Documentation, Inc., provided a report on "Bibliographical and Reference Services as a By-Product of the *Current List of Medical Literature*" (February 1959) which was stimulating and suggestive, and helped to clarify some tough issues.

The cheerful assistance that Mrs. Helen F. Rich, who had also been connected with the old Welch Project, gave to the preparation of this report is gratefully acknowledged. The entire administrative staff of the National Library of Medicine gave unflagging aid. The opinions and judgments expressed in this Report are those of the Principal Investigator, Mr. Seymour I. Taine, Editor of the *Index Medicus*, and the Project Administrator, Dr. Frank B. Rogers, Director of the National Library of Medicine.



## *Contents*

1. Introduction and History.....	1
2. Preliminary Considerations.....	8
3. Photographic Equipment and Processing.....	13
4. Composition.....	20
5. Punched Card Preparation.....	32
6. The New <i>Index Medicus</i> System.....	43
7. Operational History.....	64
8. Cost.....	72
9. General Appraisal.....	80
10. The Bibliographic Retrieval System.....	88
11. Applications.....	95

# Table of Contents for Figures

FIGURE 1	<i>Current List</i> Register of Articles—Specimen page . . . facing page	2
FIGURE 2	<i>Current List</i> Subject Section—Specimen page . . . . . facing page	2
FIGURE 3	<i>Current List</i> Author Section—Specimen page . . . . . facing page	2
FIGURE 4	<i>Index Medicus</i> Form of Entry (English Language) . . . . .	10
FIGURE 5	<i>Index Medicus</i> Form of Entry (Foreign Language) . . . . .	10
FIGURE 6	Listomatic Imprinting Area . . . . .	15
FIGURE 7	Photograph of Stripping Box . . . . .	18
FIGURE 8	Maximum Vertical Size of Type Styles Available on IBM Electric Typewriters . . . . .	21
FIGURE 9	Comparison of Principal Features and Functions of Punched Tape Typewriters . . . . .	25
FIGURE 10	Runover Cards . . . . .	28–29
FIGURE 11	Experimental Punched Card—Keypunch Fields . . . . .	34
FIGURE 12	Non-Entry Mainheading Card . . . . .	35
FIGURE 13	Non-Entry Subheading Card . . . . .	36
FIGURE 14	Non-Entry “See” Reference Card . . . . .	37
FIGURE 15	Non-Entry “See Also” Reference Card . . . . .	38
FIGURE 16	<i>Index Medicus</i> Operations Flow Chart . . . . .	44
FIGURE 17	Subject Entry Card . . . . .	48
FIGURE 18	Senior Author Card . . . . .	49
FIGURE 19	Junior Author Cross Reference Card . . . . .	50
FIGURE 20	Preliminary Card Design—Listomatic Imprinting Area . . . . .	51
FIGURE 21	Final Card Design . . . . .	52
FIGURE 22	Machine Operation Work Flow—Subject Section . . . . .	55
FIGURE 23	Machine Operation Work Flow—Author Section . . . . .	56
FIGURE 24	Schedule of Machine Operations . . . . .	58
FIGURE 25	Listomatic Program Card . . . . .	60
FIGURE 26	Stripping Mask (Film Negative) . . . . .	61
FIGURE 27	Alternate Plans for Cumulation Interfiling . . . . .	62
FIGURE 28	Summary of Costs . . . . .	73
FIGURE 29	Detailed Comparison of Costs . . . . .	74
FIGURE 30	Costs of Individual Operation . . . . .	79
FIGURE 31	Time Required for Processing Typical Monthly Issue . . . . .	83
FIGURE 32	Machine Breakdown Statistics . . . . .	85

THE NATIONAL LIBRARY OF MEDICINE  
INDEX MECHANIZATION PROJECT



# Introduction and History

**J**OHN SHAW BILLINGS, at the Library of the Surgeon-General's Office (now the National Library of Medicine), undertook the first large-scale indexing of current medical journal literature using institutional team-approach methods at the start of the last quarter of the nineteenth century. In 1879 he brought out the first volume of the first work to use the title, *Index Medicus*, and, in 1880, the first volume of the first series of the *Index-Catalogue of the Library of the Surgeon-General's Office*.

The American Medical Association began to publish a *Quarterly Cumulative Index to Current Medical Literature* in 1916, and in 1927 the *Index Medicus* merged with this to form the *Quarterly Cumulative Index Medicus*. The *QCIM* was published in Chicago, but the Library of the Surgeon-General's Office supplied from Washington index entries for material not acquired by the American Medical Association for its own collection until 1932, when the intercity collaboration proved too difficult to continue. Beginning in 1932, the AMA published *QCIM* on its own, while the Library put all its indexing efforts into the *Index-Catalogue*, then completing its third run through the alphabet. Volume A of Series 4 did not appear until 1936. The *Index-Catalogue* was particularly useful for long retrospective literature searches, because of its style of organization; it was deficient as a tool for current search, for the same reason.

The simplest and most satisfactory way to acquire an understanding of these two great indexes is by direct examination of them, and by browsing in their prefaces and letters of transmittal. In addition, the Medical Library Association *Handbook of Medical Library Practice* provides bibliographical descriptions and critical evaluations, and their history is to be found in Brodman, *The Development of Medical Bibliography*.

Their troubles were many. World War I interrupted for many years the normal publishing and distribution practices of the world, and at the same time added enormous quantities of new writing on military medicine and surgery, enough, in fact, to warrant a War Supplement, 1914–17, to the *Index Medicus*. The economic depression of the 1930's was the next major misfortune for both the Chicago and the Washington indexing operations. *QCIM*, committed to two quarterly issues and two semiannual cumulations per year, was hit particularly hard by a printers' strike in 1940, and by that time World War II had begun to increase simultane-

ously the demands for scientific information and the difficulties of maintaining access to it. By the middle of the 1950's both indexes were suffocating in backlogs.

The *Quarterly Cumulative Index Medicus* ceased to be a quarterly in 1950, putting out only its two semiannual cumulations. In an attempt to regain lost currency it postponed publication of volume 45 (covering the first six months of 1949) for five years. Finally, in June, 1959, it announced that it would cease publication with volume 60, covering the last six months of 1956. The *Index-Catalogue* continued to produce one volume a year from 1936 to 1943, then one volume in 1948, and it concluded the fourth series in mid-alphabet in 1955, with publication of volume 11. At this point, the number of entries waiting in the unpublished backlog of completed indexing exceeded the total number of entries published in four series over a period of 78 years.

During World War II, when the need for ready access to significant current information quickened, the lag in production of *QCIM* caused searchers to turn more and more to the *Current List of Medical Literature*, because it was, as it claimed to be, current. This small twenty-page weekly leaflet first appeared in 1941, through the efforts of Dr. Atherton Seidell, and was designed as a sort of order catalog for obtaining microfilm and photostat copies of articles from the Medicofilm Service of the Army Medical Library, a service extensively used by overseas military medical installations as well as by libraries and physicians in this country. The *Current List of Medical Literature* presented tables of contents of newly received journals arranged in a few broad subject categories, and it was suitable for marking, clipping, stuffing in a coat pocket, and in the end throwing away. Subject and author indexes, and cumulations thereof, were added in time. In 1945 the Library took it over as a government publication, available on subscription.

At the suggestion of Colonel Joseph H. McNinch, the Surgeon-General in 1948 appointed a Committee of Consultants for the Study of Indexes to Medical Literature Published by the Army Medical Library, and arranged for Dr. Sanford V. Larkey, under a contract between the Army Medical Library and the Johns Hopkins University Institute for Co-operative Research, to conduct a research project at the Welch Medical Library in Baltimore on problems of medical indexing, the evaluation and study of present indexes, the detailed study of subject headings, and study of the possibility of using machine methods in indexing. The Committee, drawing on the findings of the Project, in 1950 recommended that the *Index-Catalogue* be brought to a close. At the same time, it was recognized that the *Current List of Medical Literature* had been progressively forced out of the status of a throwaway and into that of a continuing resource. It was therefore

---

FIG. 1. *Current List* Register of Articles—Specimen page

FIG. 2. *Current List* Subject Section—Specimen page

FIG. 3. *Current List* Author Section—Specimen page

# BOLETIN MEDICO DEL HOSPITAL INFANTIL (México, D. F.)

Bol. méd. Hosp. inf., Méx. 14(3) 1 June 57

2620 OLMO GARCIA DE ALBA C, TOHEN ZAMUDIO A. Estudio de electroencefalogramas en niños normales. [Study of electroencephalograms in normal children.] p. 217-25.

2621 ALICERRECA G Observaciones en la artrodesis de rodilla en el niño. [Observations on arthrodesis of the knee in children.] p. 227-41.

2622 RUIZ-CASTAÑEDA M Determinación del tipo sanguíneo por fijación en superficie. [Determination of blood type by surface fixation.] p. 243-8.

2623 OLARTE J, JOACBIN A. La presencia de Salmonella, S. typhi, Shigella y Escherichia coli B4, 055:35 y 026:36, en 13 545 muestras de materias fecales examinadas en el Hospital Infantil de la Ciudad de México. [Presence of Salmonella, S. typhi, Shigella y Escherichia coli B4, 055:35 y 026:36, in 13 545 specimens of fecal material examined in Hospital Infantil in Mexico City.] p. 249-55.

2624 OLARTE J, RAMOS-ALVAREZ M, GALINDO E. Aislamiento de Shigella, Salmonella y Coli enteropatógenos de los heces rectales de 602 casos esporádicos de diarrea. [Isolation of Shigella, Salmonella y Coli enteropatógenos de los heces rectales de 602 cases of sporadic diarrhea.] p. 257-52; English transl., p. 263-8.

2625 BASILA N. Un caso de septicemia por Aerobacter con probables manifestaciones locales del fenómeno de Shwartzman. [Case of septicemia caused by Aerobacter with probable local manifestations of Shwartzman phenomenon.] p. 269-67.

2626 ALVAREZ DE LOS COBOS J, SAGACIÓN J. Un caso de ictericia obstructiva por biliar espesa. [Case of obstructive jaundice caused by thick bile.] p. 283-8.

2627 SESIONES clínico-patológicas. p. 289-97.

2628 SESIONES clínico-patológicas. p. 296-305.

2629 DE LA TORRE J. A. Hidrocefalia congénita interna. [Congenital internal hydrocephalus.] p. 307-11.

## BOLETIN DE LA OFICINA SANITARIA PANAMERICANA (Washington)

\*Bol. Of. san. panamer., Wash. 43(2) Aug 57

2630 BLÁZQUEZ J, BIANCHINI C. Nuevos casos de intoxicación crónica ocupacional por dielirín. [New cases of chronic occupational poisoning by dielirín.] p. 121-9.

2631 BASÍ FLEITAS D. La técnica empleada en un seminario de educación sanitaria para maestros rurales. [Technique used in a health education seminar for rural teachers.] p. 130-7.

2632 RESTREPO A, ECHAVARRIA A. Diagnóstico parasitológico de la malaria por el método de concentración-fagocitosis; informe preliminar. [Parasitological diagnosis of malaria by the concentration-phagocytosis method; preliminary report.] p. 138-42.

2633 PRESNALL C. Control de los animales silvestres vectores de rabia a lo largo de la frontera Mexicano-Estadounidense. [Control of wildlife vectors of rabies at large on the Mexican-U.S. border.] p. 159-62.

2634 INFORME del mes de Marzo 1957 sobre la campaña de erradicación del Aedes aegypti en los países americanos. [Report for the month of March 1957 on the Aedes aegypti eradication campaign in Latin American countries.] p. 187-6.

## BOLETINES Y TRABAJOS; SOCIEDAD DE GINECOLOGIA DE BUENOS AIRES

Bol. Soc. cir. B. Aires 41(8) 5 June 57

2635 ZAVALERA D. F., CARREÑO O, BRACADINI L. A. La vía endocervical en el tratamiento de las fistulas vesicovaginales. [Intra-cervical approach in the treatment of vesicovaginal fistula.] p. 237-43; discussion, p. 243-4.

2636 RIVAROLA J. F. Evolución alejada de una invaginación intestinal irreductible, tratada por el procedimiento de Rutherford-Montgomery. [Future development of an irreducible Montgomery operation.] p. 244-6; discussion, p. 246-6.

Bol. Soc. cir. B. Aires 41(9) 12 June 57

2637 LONGO O. F. Colicopatía por reflujo de fermentos pancreáticos. [Cholecystic disease caused by reflux of pancreatic ferments.] p. 385-9.

2638 BREA M. M., SANTAS A. A., MARTÍNEZ J. L. Hernias diafrágicas subcostales; 11 observaciones. [Sub-costal-diaphragmatic hernia.] p. 389-9.

2639 FERRERA J. A. Cáncer de mama; operación de acuerdo al concepto de la existencia de una celda ganglionar. [Breast cancer; operation in keeping with the concept of the existence of lymph nodes.] p. 287.

2640 REY A. M. Curiosa genesis de un cálculo colodociano en un paciente colocoléctomizado. [Unusual etiology of a gallbladder calculus in a cholecystectomized patient.] p. 286-9.

\*Bol. Soc. cir. B. Aires 41(10) 16 June 57

2641 CORREA-ITURRASPE M., ARUFE H. N. La cirugía plástica en las slopecias parciales definitivas del cuero cabelludo. [Plastic surgery in certain partial alopecia of the scalp.] p. 299-317.

2642 NAVEIRO R. A. Cáncer de mama hormono-sensible. [Hormone-sensitive breast cancer.] p. 316.

2643 MARINO H. Alopecia definitiva parcial del cuero cabelludo y su relación con el síndrome de la alopecia alopecia. [Partial limited alopecia of the scalp.] p. 319-21.

\*Bol. Soc. cir. B. Aires 41(11) 3 July 57

2644 MUSCOLO D., PIATIGORSKY B., WAISS M. A. Fracturas cerradas y recientes de la diáfisis tibial en el adulto. [Recent closed fractures of the tibial diaphysis in adults.] p. 323-34.

2645 BOGETTI B., ANTONELLI N., LASCANO GONZÁLEZ J. C. Actinomicosis abdominal. p. 335-44.

\*Bol. Soc. cir. B. Aires 41(12) 10 July 57

2646 DELRÍO J. M., COLLAS R. J. Hepatoma maligno (carcinoma hepático) de evolución excepcional. [Malignant hepatoma (hepatocytic carcinoma) of unusual development.] p. 346-55.

2647 NAVEIRO R. Paro cardíaco y recuperación total. [Cardiac arrest and total recovery.] p. 356-7; discussion, p. 357-60.

2648 LONGO O. F. Ripertieria maligna post-operatoria. p. 361-4.

2649 LONGO O. F., ORTIZ E. Atresia del duodeno. p. 364-9.

## BOLETIN CHIMICO-FARMACEUTICO (Milano)

Bol. chim. farm. 96(6) June 57

2650 RAVAZZONI C., VALERIO R. Azione di "factor lipotropi" sull'enteriti del fegato. [Action of lipotropic factor on liver enteritis.] p. 239-43.

2651 RUGGERI R. Dosaggio della vitamina B2 fosforilata associata a vitamina B12 ed ematoporfirina. [Determination of phosphorylated vitamin B2 combined with vitamin B12 and hemoporphyrin.] p. 244-7.

2652 MARINI-BETTOLO G. B. Metodi cromatografici ed elettroforéticos nello studio del farmaci. [Chromatographic and electrophoretic methods of study in pharmacy.] p. 248-60.

2653 SALVAGNO A. Metodo di purificazione dell'idrossido di magnesio riciclato dall'acqua di mare. [Purification method of magnesium hydroxide obtained from sea water.] p. 261-3.

2654 RUGGERI R. Solubilizzazione della reserpina. [Solubilization of reserpine.] p. 264-6.

\*Bol. chim. farm. 96(7) July 57

2655 ROCCHI B., VITTORELLI F. Determinazione spettrofotometrica nell'U.V. del clorometilico ed idrocortisone acetato associati. [Determination of chlorometilico combined with hydrocortisone acetate by ultraviolet spectrophotometry.] p. 283-6.

2656 RUGGERI R. Dosaggio dell'ematomorfina e stabilità delle sue forme farmaceutiche. [Determination of hematomorphin and its stability in pharmaceutical preparations.] p. 287-91.

2657 DE LORENZI F. Titolazione complessometrica. [Complex titration.] p. 291-301.

2656 REALDON A. M. Il cobalto nel regno vegetale ed animale. [Cobalt in the vegetable and animal kingdom.] p. 302-6.

2659 DI BLASI F. Un nuovo strumento per l'indagine nella regione dell'infrarosso. [A new instrument for research in the field of infrared rays.] p. 306-8.

2660 BARTOLI M. Sulla determinazione quantitativa dell'ammucamento del latte vaccino. [Quantitative determination of watering in cow's milk.] p. 312-4.

2661 GIALIATI L. Sulla purezza dell'olio di ricino. [Purity of castor oil.] p. 315-7.

## BOLETIN DELL'ISTITUTO SIEROTERAPICO MILANESE

Bol. ist. sieroter. milan. 35(5-6) May-June 57

2662 CARMINATI G. M. Ricerche sulla produzione di ceppi penicillino, streptomomico e cloramfenicol-resistenti nell'infezione da Bordetella pertussis. [Research on the production of penicillin, streptomycin and chloramphenicol-resistant strains in infections by Bordetella pertussis.] p. 197-205.

2663 CARACASSI U., CEPPELLINI R., FITZUS F. Frequenza della talassemia in quattro popolazioni aeree e suoi rapporti con la distribuzione dei gruppi sanguigni e della malaria. [Incidence of thalassemia in four Sardinian populations and its relation to the distribution of blood groups and malaria.] p. 206-18.

2664 NUVOLEONE U. Contributo allo studio dei rapporti tra siero-globuline ed anticorpi leucitici devianti (I). [Relations between serum globulin and complement deviating leucitic antibodies.] p. 219-30.

2665 KUJUMGEV I. Rapporti tra il potere patogeno e il potere riducibile verso il prototipo del S. antracis e delle sue forme dissociative. [Relations between the pathogenic power and reducing power toward prototipo of S. antracis and of its dissociative forms.] p. 231-2.

2666 GIOANNINI P., CAMARRE E. Ricerche sull'azione citotossica in cultura di tessuti del virus Coxsackie classici e di alcuni ceppi isolati in Italia. [Research on the cytopathogenic effects in tissue culture of the classical Coxsackie virus and of various strains isolated in Italy.] p. 236-42.

2667 ZANUSSI C., TASCINI P., ROMAGNOLI G. Il sistema propendico; considerazioni sui metodi di dosaggio della propendina e sulla sua reale importanza nel campo dell'immunità. [The propendin system; considerations on methods of determination of propendin and on its real importance in the field of immunity.] p. 243-55.

2668 TORLONE V. Tipizzazione del micrococco della mastite gangrenosa ovina e caprina e dello stafilococco responsabile della stafilococcosi del polli mediante l'agglutinazione. [Typing of the Micrococcus of ovine and caprine gangrenous mastitis and the Staphylococcus responsible for staphylococcosis of chickens by means of agglutination.] p. 256-65.

2669 DRAGONI G. Bacilli tubercolari ed estratti ad azione tubercolinica; ricerche elettroforetiche e cromatografiche. [Tuberculous bacilli and extracts with tuberculin action; electrophoretic and chromatographic research.] p. 286-73.

2670 MULÉ F., GARUFI L. Osservazioni al microscopio elettronico sull'azione dell'idrocortisone sullo sviluppo della Salmonella typhosa. [Electron microscopic observations on the effects of hydrocortisone on the development of Salmonella typhosa.] p. 274-82.

2671 VALCOURNE M. L., BAGGINI A. Sulle sostanze antibatteriche di origine entomologica. [Antibacterial substances of entomological origin.] p. 283-305.

2672 GUERRA M. Ricerche sulla sopravvivenza e sulla persistenza di alcuni caratteri batteriologici e di alcune tossine nella panna. [Research on the survival and the persistence of various bacteriological characteristics and on the pathogenicity of Brucella in cream.] p. 305-10.

2673 GARGANI G., BENELLI S. Esperienze sulla vaccinazione anti-brucellare della cavia con un vaccino eritrolato e adsorbito. [Experience on anti-brucellar vaccination of guinea pigs with a cryoprecipitated and adsorbed vaccine.] p. 311-20.

2674 ANGELUCCI R. Manometro di Warburg modificato per ricerche sul metabolismo di tessuti animali coltivati in vitro; possibilità di impiego. [Modified Warburg manometer for research on the metabolism of animal tissues cultivated in vitro; possibility of use.] p. 321-8.

## BOLETIN DELLE MALATTIE DELL'ORECCHIO, DELLA GOLA, DEL NASO (Pisa)

Bol. mal. orecchio 75(1) Jan-Feb 57

2675 SCALORI G. Cancro laringo-tracheale con metastasi sottocutanee. [Laryngo-tracheal cancer with subcutaneous metastases.] p. 1-6.

2676 MAGGIO E, JODICE S. Modificazioni anatomopatologiche consecutive a trattamento corticosteroideo locale nell'otite media purulenta cronica e negli echi degli interventi chirurgici sull'orecchio medio. [Anatomopathological changes caused by local corticosteroid treatment in chronic purulent otitis media and in complications caused by middle ear surgery.] p. 7-24.

2677 GARDENHOF G. Un caso di pseudobulbomieloma della base della lingua. [Case of pseudobulbomieloma of the base of tongue.] p. 25-9.

2678 BARTALENA G., CAPALDI S. Ectasia del cochlèa e pressione arteriosa retinica. [Cochlear ectasia and arterial retinal pressure.] p. 30-43.

2679 SALLIS B. Difficoltà interpretativa del danno acustico rilevato in un traumatismo cranico. [Difficult interpretation of hearing disorders in a person with cranial injuries.] p. 44-57.

2680 FUSARI C. Su una cisti e una fistola del dotto tiroglossico e sede insolita. [Unusual location of a cyst & fistula of thyroglossal duct.] p. 58-67.

Bol. mal. orecchio 75(2) Mar-Apr 57

2681 FILIPO D., BERNICCHI L. Il comportamento delle mastoidi nelle tonsilliti. [Behavior of mastoid cells in tonsillitis.] p. 93-9.

2682 TAVANI E., MARIOTTI M. Sul rapporto tra manifestazioni morbose faringiche e artropatiche cervicali. [Relations between pharyngeal diseases and cervical arthropathies.] p. 100-22.

2683 CLERICI E., BELLINA M. L'otomielite acuta del massellare superiore nel lattante. [Acute otomielitis of superior maxilla in infant.] p. 123-56.

2684 MICHELI-PELLEGRINI V., GIACCI F. Il comportamento delle prove sismologiche durante il periodo pre-menstruale e mestruale, in rapporto ad eventuali controindicazioni alla tonsillectomia. [Behavior of blood tests as premenstrual and menstrual period in relation to possible contraindications to tonsillectomy.] p. 137-45.

2685 CASSANO N. A. Su di un caso di palato invertito emodiali. [Case of inverted ethmoidal palatoma.] p. 166-74.

2686 FUSARI G. Sulla relazione statistica fra fumo di tabacco e cancro laringeo; indagine su 102 casi. [Statistical report on relations between tobacco smoke and laryngeal cancer; report on 102 cases.] p. 175-9.

2687 FINZI A., CLERICI E. I sarcomi indifferenziali della faringe; contributo casistico. [Undifferentiated sarcomas of the pharynx; case reports.] p. 180-94.

## BOLETIN D'OCULISTICA (Bologna)

Bol. ocul. 36(1) Jan 57

2688 NICOLATO A., MORONE G. La cornea litiassica; caso illustrato nella pratica. [Use of hypophysectomy in keratoplasty.] p. 3-6.

2689 LEONARDI F. Osservazioni comparative fra metodi di anestesia ed acinesia locale e curaria nella chirurgia della cataratta. [Comparative methods of anesthesia and local curative anesthesia in cataract surgery.] p. 9-44.

2690 GUZZENATI G. Sul valore clinico dell'ansipatia e dell'ansiodominanza. [Clinical value of ansipatia and of ansiodominance.] p. 45-58.

2691 BIETTI G. Yasushi Nakamura. p. 69.

\*Bol. ocul. 36(2) Feb 57

2692 REDI F. Sulla atrofia progressiva dell'iride; a proposito di un caso di atrofia progressiva anisocoria. [Progressive atrophy of the iris; concerning a case of essential progressive atrophy.] p. 65-80.

2693 WIRTH A. Contributi a tecniche terapeutiche intese a modificare il regime di produzioni dell'umor acquoso. I. Alcune osservazioni sull'impiego del diamo, con particolare riguardo al preparato ad azione ritardata. [Therapeutic procedures for modifying the rate of flow of aqueous humor. I. Several observations on the use of diamo, with special reference to preparation of retarded action.] p. 81-8.

2694 WIRTH A. Contributi a tecniche terapeutiche intese a modificare il regime di produzioni dell'umor acquoso. II. La comminazione di acido ascorbico e la formazione postoperatoria della camera anteriore. [Therapeutic procedures for modifying the rate of flow of aqueous humor. II. Administration of ascorbic acid in case of postoperative formation of the anterior chamber.] p. 87-90.

# CURRENT LIST of MEDICAL LITERATURE

STREPTODORNASE AND STREPTOKINASE

<b>metabolism</b>	liver funct. tests in (Rus)	10972	Hodgkin's dis., primary	1226	<b>etiology and pathogenesis</b>	
enzymatic mechanisms, review	retention of gastric contents following subtotal gastrectomy, statist.	10270	leiomyoma (Ca)	9697	allergy	7109
neutral steroid excretion in newborn inf.	traum. calcitulia, prev. by magnetic metal retriever in cattle	5567	lympho-sarcoma, primary	1227	fluoride dentifrice	7721
<b>therapeutic use</b>	volvulus, in total diaphragmatic hernia (Dut)	2506	metastases to bone	10101	<b>STOMATITIS, ULCERATIVE see VINCENT'S INFECTION</b>	
cancer of breast, with radiother.			protracted evolutive (Dut)	2520		
<b>STEROLS see STEROIDS</b>			small malignant (mmora, case review & comparison with data on gastric ulcer)	10354	<b>STRABISMUS</b>	
<b>STEVENS-JOHNSON SYNDROME see ERYTHEMA MULTIFORME</b>			<b>blood in</b>		<b>see also AMBLYOPIA</b>	
<b>STILBAMIDINES see STILBENES</b>			ABO group frequency in Negroes	5448	binocturnal vision field in concomitant strabismus (R)	1726
<b>STILBENES</b>			erythrocytes, morphol. & prod. in cancer & precancer (Rus)	10978	concomitant, vertical deviation (R)	1720
<b>see also DIETHYLSTILBESTROL</b>			globin content (Rus)	10979	exophoria with convergence insuff., psychogenic factors	4111
4,4-dihydroxy- $\alpha$ , $\alpha$ -diethylstilbene diphosphate as substrate of prostrate phosphatase (Ger)	2459		thrombocytopenia in cancer & precancer (Rus)	10980	equid, diag. & ther. in GP	7676
diphenylthiase & stilbene deriv., prep. & antitumor effect on CNS (U)	4560		<b>case reports</b>		<b>complications</b>	
hexestrol diphosphate & monophosphate, pharmacol. (R)	4839		granuloblastoma (Ger)	4247	amblyopia, objective determ. of visual acuity (R)	2697
<b>effects</b>			leiomyoma of cardia (Rus)	10920	<b>surgery</b>	
4-[ $\beta$ , $\beta$ -dichloroethylamino)-ethyl]-hydroxystilbene, antitumor eff. (R)	4625		multiple aeurileumoma of anterior wall (Ca)	9699	concomitant, statist. (Fr)	1587
diphenylthiase & stilbene deriv., ganglionic blocking agents (R)	4561		with metastases to liver, bile ducts & regional lymph nodes, clin. pathol. conf. (Por)	2329	indic., timing & selection of type of operation (Sp)	6110
hexestrol & $\alpha$ , $\alpha$ -diethyl-4,4'-stilbene diphosphate on glycogen content of prostate in dogs (R)	7346		<b>complications</b>		<b>STREPTOCOCCAL INFECTIONS</b>	
hexestrol, eff. of carbamide & tolbutamide on physiol. response (Fr)	1547		peptic ulcer (Fr)	2191	<b>see also ENDOCARDITIS, SUBACUTE BACTERIAL</b>	
hexestrol on carcass composition & efficiency of food utilization on fattening lambs	2073		peptic ulcer, x-ray manifest. (Sp)	4361	<b>see also RHEUMATIC FEVER</b>	
4-hydroxystilbene & 4-hydroxydiphenylthiase deriv., antiproliferative & antitumor activity (R)	4624		peh. into peritoneal cavity (R)	6162	<b>see also SCARLET FEVER</b>	
stilbemidine, antifungal eff. on <i>Mucedella mycetozoi</i>	7460		ulceration, diag. value of manico sign	758	Streptoc. pyogenes causing otitis media & tonsillitis	6763
<b>therapeutic use</b>			<b>diagnosis</b>		<b>complications</b>	
hexestrol diphosphate in prostate cancer (R)	4865		cytology, techniques (Por)	3610	rheum. fever, epidemic in Air Force recruits,	78
phosphoryl stilbenes in prostate cancer (Ca)	9693		early (Rus)	10904	rheum. fever, prev. with oral penicillin, in Air Force recruits	79
stilbemidine in essential trigeminal neuralgia (R)	4012		early (Sp)	4345	<b>diagnosis</b>	
<b>STILBESTROL see DIETHYLSTILBESTROL</b>			early, coordination of anamnesis & x-ray (Ger)	11273	antistreptolysin titer (Ger)	4232
<b>STILLBIRTH</b>			gastro-chromoscopy (Rus)	10903	<b>experimental</b>	
caused by fetal erythroblastosis	6316		Segal's tubeless gastric analysis using aurea A resin compound	5394	cardiac lesions in rabbits	925
<b>STILL'S DISEASE see ARTHRITIS, RHEUMATOID</b>			x-ray (Rus)	10961	intranasal, with group A streptoc., in rabbits (Ca)	3681
<b>STINGS see BITES AND STINGS</b>			<b>differential diagnosis</b>		<b>in infant and child</b>	
<b>STOKES-ADAMS DISEASE see HEART BLOCK</b>			peptic ulcer, test of maximum gastric secretory response to continuous intravenous infusion of histamine	6120	mucocutaneous reactions after penicillin-probenecid ther.	460
<b>STOMACH</b>			<b>etiology and pathogenesis</b>		upper resp. tract infect. in child. (Ser)	10964
<b>see also PYLORUS</b>			endocrine dis. as predisposing factor (Ger)	7063	<b>prevention and control</b>	
<b>abnormalities</b>			nutritional factor (Rus)	10971	pharyngitis, benzathine penicillin G in epidemic among air force personnel	5484
aberrant pancreatic tissue in gastric wall, differ. diag. from peptic ulcer	1333		<b>in infant and child</b>		<b>therapy</b>	
<b>anatomy and histology</b>			adenoma (Ca)	9795	lungs, erythromycin (Ger)	11283
retention between Golgi appar., mitochondria & subapical granules in cryptic cells	3705		<b>metabolism</b>		<b>STREPTOCOCCUS</b>	
<b>blood supply</b>			catalase in blood & liver in cancer & precancer (Rus)	10985	differentiation from <i>Diplococcus pneumoniae</i> by bile solubility test	6193
arteriovenous anastomosis, role in hemorrh. (Pol)	8024		<b>physiology</b>		pyogenesis, serotypes, prevalence in Gt. Brit.	7431
gross & microscopic anat. & neural regulation in rate	1415		eff. of stimulation of gastric interocceptors on salivation in cancer & precancer (Rus)	10973	toxin, eff. of intravenous admin. on course of exper. nephrosis	6115
<b>calculi</b>			gastric acidity & blood iron levels, correlation	757	<b>effect of drugs on</b>	
gallstones entering through cholecystogastric fistula, case report	1175		<b>statistics</b>		trypsin & cetyl trimethylammonium bromide on Streptoc. pyogenes structure, permeability & metab.	5928
<b>diseases</b>			cardiac	7669	<b>immunology</b>	
<b>see also GASTRITIS</b>			clin. statist. (Ger)	259	bacteriophage of hemolytic streptoc., factors influencing infection with susceptible host cell	5907
cardial sclerosis, vagotomy & gastroenterostomy, case report (Ger)	11428		granulomatous polyp (Rus)	11002	long chain form. by A strains in presence of homologous antiserum as type-specific reaction	6906
diast. with venous thrombosis of leg in abdom. surg. (Fr)	7096		<b>surgery</b>		<b>metabolism</b>	
esophagogastric junction, surg., esophagogastric anast. & Roux-Y	1900		gastroenterostomy with vagotomy, technic	11420	C polysaccharides, eff. on collagen A solutions (Fr)	4059
infiltrative eosinophilia of gastric wall (Cs)	9013		in peptic esophagitis with diaphragmatic hernia, indic. of method	9698	lactase, lactase activity determ. (Rus)	7114
			progr. (Fr)	6692	lactate, methionine requirement	3479
			tube replacement of esophagus, priority of work of Dr. Dan Gavrilu	7992		
			<b>transplantation</b>	7157		
			growth of embryonic stomach on exterior chest wall of adult corticosteroid-treated homologous hosts	3675		
			<b>STOMACH NEOPLASMS</b>			
			after gastroenterostomy (Fr)	2190A		
					<b>STOMACH ULCER see PEPTIC ULCER</b>	
					<b>STOMATITIS</b>	
					<b>case reports</b>	
					Infect.	7776

Symbols in parentheses indicate foreign language articles; absence of language symbol indicates articles in English. For full explanation see end of Subject Index.

# CURRENT LIST of MEDICAL LITERATURE

Napaikov P N-Odescaichi C P

Napaikov P N	10720	Nechaeva E A	10740	Neto M V	9252	Niccole A V	11638	Noble T A	8652	Notti H J	9059
Nappee J	2347	Nechaeva I D	11005	Netoušek M	3674	Nichols J	4468	Noble W J	3898	Novák J	3704
Narquin H A	10635	Nechanický R	9723	Netter A	4100	Nichols W W	242	Nobles E R Jr.	5377	Novikova M	3851
Naranjo J	1381	Neches H	1043		4101	Nicholson D N	2116	Nobles W L	929	Novikova V	3765
Naranjo O	9197	Nechtow M J	2410		4935	Nicholson E E	5534	Noblet P	1490	Novotný J	9696
Narayananarao D	5217	Needy C K	1759	Neu H N	7528	Nicholson M	4016	Nocks E	10537		9698
	5218	Neenan E W	7769	Neuberger A	2524	Nicholson T F	3438	Nocquet P	4938		9716
	5219	Neergaard C F	7405	Neuberger F	11135	Nick J	9424	Noe O	244	Norykova S I	7114
Narbona Arnau B	6993	Neetens A	366	Neuburger O W	10885	Nickel W O	10272	Nücker J	4313	Nowak T	7458
Nardelli L	1685	Nefedov V B	10151	Neufeld A H	3585	Nickel W R	28	Nofel P	2184	Nowicki P	8025
	4211	Neff W D	1875	Neugebauer W	11418	Nickerson M	6394	Nogard O	7686	NReer E	6460
	7194	Negreiros E B	2779	Neuhaus O W	2093	Nickel W O	7964	Ngsetvik H	536	Nuffield E J	6937
Nardi D	4580	Negrete J	9154	Neuhausner E B	1151	Nickey W M	181	Nogueira C	8970	Nulla y Nulla B	2357
	4561	Negri F	4751	Neumann E	1286 3097 3150	Nicol B M	7478	Noguera Muñoz J	9079	Nuffen A I	9236
	4835	Negri L	3890	Neumann H W	3157 4196 4210	Nicol T	7520	Noix M	8497	Nuffex C	2390
		Negri M	7134	Neumann P	8841	Nicolai C H	10688		6498	Nunke P V	9057
Narghski J	7567		7337	Neumann T W Jr	7648	Nicolas A	8654		5519	Nuffen Basco M	4787
Nerpozzi A	2754	Négre R	2212	Neumann Y B	5019	Nicoles E	304	Nojima T	5276	Nungester W J	10892
	2755	Negri S	9616	Neumark R	8039	Nicoletto A	2688	Nold B	5278	Nunn J	6454
	2756	Negro G	8774	Neumayer E	7044	Nicolau S	7257	Noleto P A	8963	Nuffo-Beato	9125
	2757	Negro R C	2394	Neumeyr A	11207	Nicolie P	3343	Nonclercq E	3320	Nurge E	6627
Narvaez V	1387	Negus V	163	Neustadt D	4404		4087	Nonclercq M E	3314	Nusbaum M	2213
Nash E H	5840		164	Neurville	4974	Niebel H H	11371	Nore P F	1242	Nutt D G	6205
Nash J B	1056	Neher R	1859	Neuwirt K	9894	Niederle	7769	Norambuena M	8432	Nutting C A	3750
Nasto J	4351	Nehill J	9431	Neuwirth M	9746	Niederle B	9747	Norbury F G	5248	Nuvolone U	2664
	4385	Neidle A	2105	Neveling R	10212	Nielsén J	3668	Nordin B E	5636	Nwokolo C	11048
	7093	Neidle A	2105	Neven C	9396	Nielsen K	183	Nordman R	4449	Nyárády I	7813
	10040	Neill D W	8308	Neven G	4033	Nielsen P W	3990	Nordmann J	4011	Nye R E Jr	3895
Nasir Pascha M	7459	Neira Villana S	1389	Neveer G	4055	Niemegeere K	1264	Nordmann R	4011	Nyhus L M	1339
Nasro I	7337	Nékmán L	2595		4055		1265	Nordström K	439		10319
Natali R	1603	Nekrashevych N I	7118	Neves J dos S	9002	Nieper H A	579	Norgan A	1096	Nyíró G	5183
Natalini E	7991	Nelken D	5010	Nevlaser J S	1786	Nieto A M	9303	Nori Bufalini G	8703		5184
	7992	Nelken S	9577	Nevill G E	4459	Nieto Nieto G	3977	Noriki H	5275	Nyström S	10268
Natalini G	8836	Nell E E	774	Nevill L B	4459	Nieves E E	1276	Norin A	10	Obata W	3922
	8837	Nelson A	546	Neville G J	755	Nieweg H O	9913	Norman A	2094	Oberdoerster F	4237
Nath H K	5215	Nelson A J	3495	Newberne J W	5555	Nigro N	7338	Norman A P	2114	Oberling C	3071
Nathanson N	777	Nelson C V	1817	Newby D	10094	Nihoul E	9392	Norman L R	3924		3076
Naudin E	3101	Nelson E	5602	Newcombe H B	9911	Nijls P	264	Norman P S	5911		7502
Naudin E P	6542	Nelson E S	31	Newell F W	112	Nikitina A F	10166	Norman W B	10381	Oberman J W	4019
Naumann H H	4274	Nelson G H	1026	Newhall S M	3468	Nikolitsch M	1976	Norpoth L	7440	Ober Polleri J	9053
Naumova T S	10910	Nelson L E	7353	Newington D K	9669		1983	Norris F W	2526	Obney N	3522
		Nelson M M	1413	Newman B J	5765	Nikolopoulou P	444	Norris W P	9948	O'Brien F W	7640
Naumton R F	155	Nelson P A	230	Newman E V	3942	Nikolowski W	11302		11563	O'Brien G R	1224
Nava G	8810	Nelson S W	1168	Newman H F	10341	Nilsson J M	1863	Northrop J H	5933	O'Brien J E	5514
Nava P	2781	Nelson T E	11526	Newman H R	1199	Nimb M	10802	Northup D W	1441	O'Brien J R	9329
	2784	Nelson T G	1344			Ninane G	1664	Northup J D	10341	O'Brien K	11595
Nava S	8512	Nemes J	7242	Newman R	3576		1669	Norton M L	215	O'Brien R T	2054
Navarranne P	9388	Nemeth L	4837	Newson B D	11828	Nishihara G	10329	Norymberski J K	5893	O'Brien W A	5588
Navarre G C	7587	Németh T	7813	Newton A	6067	Nishihara H	8425	Nosek J	3772	Obwegeser H	7789
	7588	Nemiro E A	10961	Newton A J	2970	Nishimov R	10392	Nosko L	6688	Ocampo A N	6426
Navarrete y Sierra A	2619	Nenashev P	9981	Newton G A	2101	Nisimov R	10393	Nosová T	9759	Ochhalani B	2341
Navarro M D	8428	Nenna A	9428	Newton J W	2101	Nissim J A	5903	Nossai E	5398	Ochaner A	1918
Naveiro R	2642	Nenzellus C	468	Newton M	7366	Nitzani C	5008	Noeti Nava J	4579		6592
	2647	Neporent M I	10484	Neselof C	10001	Niutta R	9352	Notario A	2317		10123
Navrátil J	3826		10457	Ngai S H	1060	Nivaldo J	8956		2318		10324
	3829	Nepveux P	1531		1061	Nixon D A	6729		2319	Ochaner A J	10135
	3869		2189		1062	Njaa L R	7480	Notter A	3100	Ochaner S	10123
	9753	Nerescu V	1595		1063	Njemirovskij Z	2407		3161	O'Connell T C	8090
Navrátil L	11220	Neri I	8824	Ngu V A	11050	Noack H	11456		4985	O'Connor N	2861
Navratelki I	411	Nesbitt R E Jr	8619	Nieussat P	1481	Noah J W	5342	Notterman J M	11479	O'Connor G T	739
Ney C P	7656	Nestel B L	5547	Nieusant-Ansault R	1528	Noble C E	9939		11460	O'Connor V J	5197
Naylor W G	2490	Nestel H M	5547	Nibley C Jr	6067	Noble N L	3950		11481	Oddie T H	6923
Nayrac P	9418	Nestorides-Batopou-443		Niccolai N	8763	Noble R L	4481		11482	O'Dell B L	5655
Nazaro P	1686	Joe T		Nicelli F	2258	Noble S	8426			Odescaichi C P	4629
Nead M H	8411	Neter E	5631	Nicholas D J	2554						
Neber H	5071										
Nechaeva E A	10732										



redesigned in 1950 in more suitable form and arrangement with the aim of achieving as high a degree of promptness, comprehensiveness, convenience in use, and expansibility as could be provided with the means available.

During the first half of the period, 1950–60, then, there were two medical indexes, one *QCIM*, generally preferred for its style and format, and the other, *CLML*, demanded for reasons of currency. Coverage of the field, however, was inadequate even with the aid of both of them. *QCIM* included some 60,000 items annually, as against over 100,000 to be found in *CLML*. Since the best estimates available indicated that around 220,000 articles were published annually in the total medical literature, the National Library of Medicine and the American Medical Association once again explored the possibility of collaboration in indexing. Various divisions of labor were considered: by language, by hemisphere of journal origin, by subject matter, *e.g.*, clinical versus experimental medicine, and so forth, but the medical sciences do not lend themselves to arbitrary, mechanical, watertight divisions, and these attempts did not get very far.

Some time before the *Quarterly Cumulative Index Medicus* ceased publication in 1959, improvements in the *Current List* had been under consideration. The National Library of Medicine Act had been passed in 1956, and a little over a year later, at the meeting of the NLM Board of Regents in November 1957, a proposal for action began to take shape.

#### THE PREDECESSOR PUBLICATION

The *Current List* in 1958 (see sample pages Figures 1–3) consisted of three separate sections: register, subject, and author. The register section was a serially numbered listing of the tables of contents of journals, under journal titles in strict alphabetical array. The subject section consisted of main headings and standard subheadings, under which a third element (in NLM jargon called the “modification”), a one-line annotation in lieu of title, pinpointed the content of a specific article and was keyed to the full citation by use of the serial number. The author section listed all authors’ names, again using the serial numbering device to connect each name with the full article citation appearing in the register section. Ten regular issues were published each year, with semiannual cumulations of the subject and author sections appearing as the June and December issues.

*Coverage.* About 1,600 journal titles were regularly indexed. From these journals came an annual indexing payload of some 110,000 articles. The articles represented a broad cross section of medical literature, well balanced according to geographic, linguistic, and subject aspects. Technical reports of medical research projects were also indexed. In terms of quantity of articles indexed, the *Current List* was the largest indexing service of the literature of a specialized subject anywhere in the world. Despite its extensive coverage, the *Current List* was indexing only about one half of the available material.

*Currency.* The currency record of the *Current List* was generally quite creditable.

The monthly issues and the two semiannual cumulations appeared regularly. A report made in 1954 indicated that 56 per cent of all the material published was less than a half-year old. As would be expected, the English language and American segments were considerably more recent: 32 per cent of the English language articles and 37 per cent of those of purely United States origin were under four months old; 93 per cent of the American material appeared within the half year. The fact that these figures were computed from the dates of issues appearing on the journals rather than from the actual dates of publication or receipt in the Library added to the impressiveness of this record.

The overall currency of the *Current List* was affected adversely every six months. This was due to the periodic omission of a regular issue containing new material, which then would back up in the files while the cumulated index was being assembled. Over the next few months this publication backlog would eventually be dissipated, only to have the cycle repeat itself semiannually.

*Format.* Despite certain shortcomings, the trisectional arrangement of the *Current List* stood up quite well as a relatively simple and economical means of recording such a great mass of bibliographic data. Required by budgetary strictures to adhere to an annual limit of the number of pages used in printing the *Current List*, the Library found it essential that the format provide for maximum accessibility and coverage at a low cost in both page-space and dollars. By giving the title abbreviation, volume, issue number, and date in the register just once for all the articles in a journal issue, and by using a mere number "address" under the entries in the subject and author indexes, considerable space was saved. In so doing, a third approach to the material, by journal title, was added to the traditional access by subject and author.

The shuttling back and forth from one section to another in order to find complete information irritated many users of the *Current List* who were accustomed to finding elsewhere a complete entry. A more profound objection to this format was the fact that the division of the entry among the three sections precluded its ready use for any other listing short of reassembling the parts. Consequently, even in the preparation of its by-product, the *Bibliography of Medical Reviews*, a completely new recasting and composition of the entries was necessitated. Finally, the overall page design and legibility of the three sections, conceived primarily from criteria of economy, left something to be desired.

*Production.* Production of the *Current List* involved the typing of register, subject, and author entries on individual three-by-five inch slips, the numbering of these slips, the arrangement of the slips in the respective sections, and the hand mounting of the individual slips by a shingling technique modified from the patterns pioneered by the Department of Agriculture Library and the Library of Congress.

The numbering system especially presented an inescapable bottleneck. The numerical addresses for each of the individual register, subject, and author

entries had to be stamped manually in the exact location on the slip. This key operation could not, however, commence until all of the typed copy for a regular monthly issue had been gathered and arranged in the order of appearance of the articles in the register. Inasmuch as the numbers for the articles could not be known beforehand, this tedious operation could only be performed, in sequential order, by a single individual. By performing the mounting and numbering on a daily twenty-four hour basis, these operations could be telescoped into the few calendar days available in a given month and the deadline could be met.

Following preparation of printer's plates, each monthly issue was laboriously torn down, the thousands of slips were interfiled with those from preceding monthly issues, and then were reshingled, again by hand, for the six month cumulation. It was an ingenious technique; but, with each half-yearly volume including half a million slips, the *Current List* approached its utmost limits and offered scant prospect for expansion or improvement.

#### PROPOSED ACTION

Increasing pressure on the *Current List* to do more and to do it better and faster helped to bring about a report to the National Library of Medicine Board of Regents in November 1957 on progress, problems, and possibilities in indexing. Discussion of the report led to the suggestion that funds be sought wherewith to investigate the feasibility of mechanization. There was prepared in January, submitted in February, and approved in April, 1958, an *Outline of a Proposal to the Council on Library Resources, Inc.*, with the

Specific aims [of] develop[ing] and demonstrat[ing] in the field of medicine improved methods for the rapid and efficient publication of comprehensive indexes to the literature of broad scientific fields with simultaneous provision for meeting the requirements of specialties within these fields, making use of hitherto unutilized mechanical applications.

The Council on Library Resources agreed to make the sum of \$73,800 available to the National Library of Medicine over a period of two years (July 1958–June 1960) for undertaking this project, and the Department of Health, Education and Welfare officially accepted the grant in June 1958.

The assets and resources of the National Library of Medicine at that point were several and significant. First, there was indexing experience, 80 uninterrupted years of it, with considerable variety in procedures and products to its credit. The Library staff was steeped in the theory and practice of subject headings, ephemeral and "permanent," in classified and alphabetical arrangement, in card catalog and published index, and accustomed to the complexities of great size and the point of view of both librarianship and medicine.

Second, the Library had the largest collection of medical periodicals in the world to work with. It knew what there was and what was asked for. Its acquisition policies were subject to continual testing by the demands made on its reference services. All material could be evaluated at first hand.

Third, NLM had learned how to work with large quantities of material, keeping it moving and keeping track of it as it moved. There are certain problems that do not arise until large quantities of material are dealt with. It would be hard to overestimate, for instance, the value of what *Current List* experience had taught in how to adjust the order of processes, so that backlogs may be kept close to the ideal zero at all stations, without causing any station to run out of work.

Next, the staff was qualified not only by education and training in library work, but also by an unusually broad working knowledge of foreign languages. The staff had also acquired familiarity with typographical design and problems of the printing industry, and knew what was involved in composition, proofreading, assembly, and in meeting production deadlines.

Less important, perhaps, but still worthy of mention, was the Library's experience and repeated success in taking reorganization in stride. The *Current List* alone had in the course of eight years made three complete physical moves from one building to another without interruption of its schedule.

So much for the resources. The lacks and limitations included (1) restrictions inherent in the government framework, (2) lack of mechanical training, (3) the limited number of personnel available to work on the project, especially during the first 18 months when the *Current List* was still continuing, and (4) limitations of the physical plant.

Under rigid government rules, grant funds are handled in the same way as appropriated funds. Every expense has to be justified. Every investigation has to be "worth while." Some of the project activities to which government regulations proved too restrictive might have proceeded more smoothly if they had been farmed out under contract. The hiring of new personnel likewise had to be done according to Civil Service procedure.

The project officially began with the acceptance by HEW of the grant from the Council on Library Resources in June 1958. This was short notice for the acquisition of major mechanical equipment, most of which requires at least three or four months for delivery. Work with machines calls for considerable knowledge of machine design and capacity in addition to operating skills. At the start of the project no trained machine operators were on hand. There were available two consultants on mechanical matters; one of them had formerly been on the Library staff, and the other on the staff of an earlier research project.

The physical plant consisted of about 3,500 square feet of a third floor, 59 steps up from ground level, with no elevator. Partial sound proofing and air conditioning had recently been installed. The atmosphere was, however, not sufficiently clean to permit processing of photographic film on home ground.

These were the resources and limitations with which NLM set out to attain the following objectives:

1. To cover more journals, up to nearly twice as many articles as were currently being covered.

2. To improve currency still further.
3. To eliminate tedious composition, filing, and proofreading procedures.
4. To improve legibility.
5. To eliminate the shuttling back and forth from index to register that the *Current List* required of the user.
6. To discover and implement multiple and derivative uses of the prepared material; and permit such by-products as the *Bibliography of Medical Reviews*, or special subject bibliographies, to be prepared without completely recasting the entries.
7. To provide a demonstration of methods that might aid scientific indexes in general, and assist in similar enterprises in other fields.
8. To distinguish among index imperfections which might be cured by money, which by technological advances, which by education, arbitration, and convention, and which cures might be mutually incompatible.

By the end of June 1958 considerable work had been done on project design. Slowly, by study, investigation, and conference, the general outlines of how to go about the project had been evolved. Development of machines was not part of the plans. Machines and equipment were to be chosen from what was already available in other lines of work; they were to be adapted and combined rather than to be specially designed. At one stage, development of a special type face was contemplated, but this was abandoned. With the exception of a single box made for stripping film into page format, all the equipment was standard and generally available, though not always ideally suited to the particular requirements of the job. The work was done on the premises and by the augmented staff of the NLM Index Division, aided by consultants, rather than through hiring a specialist to take charge or by farming the work out under subcontract. The Index Division declared no moratorium in its other business, but throughout the project carried on the work of seeing the *Current List* through the final December 1959 issue.

#### REFERENCES

- BILLINGS, JOHN SHAW. Our medical literature. Transactions International Medical Congress (7th). London, 1881. p. 54-71.
- LARKEY, SANFORD V. The Army Medical Library Research Project at the Welch Medical Library. *BULLETIN* 37: 121-4, April 1949.
- ROGERS, FRANK B., AND ADAMS, SCOTT. The Army Medical Library's publication program. *Texas Rep. Biol. Med.* 8: 271-300, 1950.
- LARKEY, SANFORD V. The Welch Medical Library indexing project. *BULLETIN* 41: 32-40, January 1953.
- BRODMAN, ESTELLE. The Development of Medical Bibliography. Medical Library Association, 1954. (especially Chapter 5)
- Medical Library Association. Handbook of Medical Library Practice. 2d ed. Chicago, American Library Association, 1956. (especially p. 358-365)
- BRODMAN, ESTELLE, AND TAINE, SEYMOUR I. Current medical literature: A quantitative survey of articles and journals. Proceedings of the International Conference on Scientific Information (Washington, 1958) v. 1, p. 435-447.

## Preliminary Considerations

THE LARGEST and most significant bottleneck in the *Current List* system was the shingling operation and its attendant difficulties. The heart of the new system had to be a solution to this problem. From the inception of the idea for the project, it had appeared that one of the new automatic high-speed step cameras which had come on the market would answer the needs. This was an important jumping off place.

*Style of Entry.* The feeding of material into such a camera seemed to point to the requirement of unit style of entry, as opposed to the fragmented pattern of the old *Current List*. Using unit entry, repeated complete and unchanged wherever entry is made, would mean that the decision on entry need be made only once, that typing (with mechanical reproduction thereafter) need be done only once, and that revision need be performed only once. It might establish the possibility of using original entry cards for a variety of by-product compilations and special searches. It would add to user convenience. But the decision to adopt unit entry brought further problems, of which the foremost was the greater consumption of space and, therefore, higher printing costs as compared to the split citation which is more economical. To minimize this effect, it was necessary to study ways and means of compressing the entry without loss of excessive information.

The entry consists of three basic elements: the name[s] of the author[s], the title of the article, and the bibliographical reference, which contains the abbreviated journal title, volume number, inclusive pagination, and date of issue. The order, form, and relative completeness of these elements may be juggled in various ways, depending on the particular criteria which are operative. All of the individual components of the entry were carefully measured and tabulated. The results proved to be useful in the many subsequent manipulations of the entry.

The periodical article titles were analyzed and found to consist of an average of 10 words, with a range of from 1 to 37 words. The words proper contained an average of 6.4 characters, or 64 characters per title without allowing for spaces between words. The average length of the title with one character space per word added, therefore, came to 74 characters.

The space consumed by the name of the author came to an average of 7.3 characters per surname, or 11.3 characters after the initials and spaces were added; the range was from 4 to 24 characters. Because there was an average of 1.5 authors

per periodical article, space for 17 characters had to be allotted for this purpose. The dispersion of a sampling of articles according to the number of authors per article proved to be as follows:

1 author . . . . .	59%
2 authors . . . . .	23%
3 authors . . . . .	10%
4 or more authors . . . . .	8%

The bibliographic reference, including the journal title abbreviation, volume number, pagination, date of issue, and language symbol, came to an average total of 40 characters. The average journal title abbreviation consisted of 20 characters, and 20 additional characters were required for the remainder of the reference, which included the designation for the original language of the article. The grand total for the complete entry, consisting of all authors (surnames and two initials only), a single language version of the title, and the bibliographic reference, thus came to an average of approximately 131 characters. The value of this intelligence in the investigations and eventual machine exploration cannot be overestimated. For one thing, this information, together with other data subsequently collected, made it possible for the first time to estimate the number of pages required for the publication in the new format.

*General Layout.* In planning the layout of the printed page there were many factors to be considered and a nice balance to maintain between pressures of economy, esthetics, and the mass of bibliographic data. Certain desiderata are mutually antagonistic. Any attempt to offer at a reasonable price all desirable fullness of information, simplicity of access, and legibility of type is brought up short by the need for long cumulations of wide coverage in volumes that can be easily grasped and lifted in one hand, can be shelved on standard shelving, can lie flat when open, and can permit scanning of large concentrations of entries with a minimum of page-turning and readjustment of focus. The *Current List* was about as large a book as is welcomed on standard shelves, and a page of almost identical size was selected for the *Index Medicus* because:

1. it was a standard Government Printing Office page size,  $9\frac{1}{4}$  by  $11\frac{3}{4}$  inches;
2. it would not prove too unwieldy in annual cumulations, even with considerable increase in the number of pages; and
3. it permitted maximum concentration of text, with pleasing widths of columns, margins, and gutters.

The wider columns, three to a page instead of four in *Current List*, were determined on grounds of legibility and maximum utilization of space, the area the camera could photograph, and the length of line the typewriter could justify.

As for size and style of type, search was made for the maximum number of characters in a square inch of page space, without using type smaller than 6 point.

*Treatment of Names.* It was decided that for each author (single or senior author

and all joint authors) the surname and two initials only were to be given; no first names would be spelled out in full; compound names would be dealt with in accordance with a strict convention rather than with the owner's preference. To those who deplore such cavalier or parsimonious treatment of names, it must be answered, first, that economy, both of space and of time, is here as elsewhere the chief controlling factor under present conditions, and, second, that more detail and precision in the treatment of names are not required for the purposes of the index. The point is to locate articles in journals, not to assume the function proper to a biographical directory.

*Titles.* Titles would be given in full, and always in English. In the case of translations, the abbreviated name of the original language would appear at the end of the citation. The English version, only, could be used for the following reasons:

1. The space limitation precludes the use of both vernacular and translation.
2. The strict unit entry precludes the use of vernacular under author and translation under subject.
3. The keyboard capacities of the typewriters do not permit a full assortment of diacritical marks.
4. The function of the *Index Medicus* in formal bibliography is not to make direct examination of the original article unnecessary.
5. English is at the present time the most widespread language of science.

It was to be regretfully expected that this translation policy would displease or distress many users. It nevertheless appeared to be the best choice open in the matter (Figures 4 and 5).

*Journal Title Abbreviations.* For journal titles it was decided to use abbreviations derived (with minor deviations) from the *World List of Scientific Periodicals* as exemplified in *World Medical Periodicals*. These were widely used and enjoy the blessing of the International Standards Organization. They are not necessarily "better" than those in *QCIM* or in the *Index-Catalogue*, but the latter tools are now of the past. A few of the *World List* abbreviations were shortened still further,

RICHARDSON WP: The Governor's Council on Occupational Health. A medium of cooperative effort for the health of the worker. N Carolina Med J 21:377-9, Sept 60

FIG. 4. *Index Medicus* Form of Entry (English Language)

KAUFMANN MT: [Problems in the care of invalids with reference to occupational classification of the handicapped] Z Unfallmed Berufskr 53:158-63, 15 June 60 (Ger)

FIG. 5. *Index Medicus* Form of Entry (Foreign Language)

all punctuation was omitted, and every member of the abbreviation was begun with a capital letter, for clarity's sake in the condensed presentation.

*Frequency of Publication.* The frequency decided upon was 12 monthly issues a year, an improvement over the 10 issues per year put out by the *Current List*. From the point of view of the publisher a month is about the shortest period in which the preparation can be made on a regular basis. From the user's point of view a month's wait between issues is tolerable, and it is easier to check one issue than four, two than eight, three than thirteen, while waiting for cumulations.

*Cumulation.* Frequency of cumulation was another problem, and a very difficult one when the annual indexing load is expected to rise toward the neighborhood of 200,000 items. A luxurious arrangement might be, for a monthly publication, semiannual cumulations, superseded by annual or biennial cumulations, which in turn would be superseded by five- or ten-year cumulations. Such a solution would be entirely beyond present means, financial or otherwise. The best compromise appeared to be twelve issues of all-new material per year and an annual cumulation appearing as promptly thereafter as possible.

Here the possibility of a workable division of labor between the National Library of Medicine and the American Medical Association again came in sight, and the old collaboration was renewed. It was agreed that an annual *Cumulated Index Medicus* would be published and distributed by the American Medical Association in Chicago. The cumulation and photography would be done on the machines at the National Library of Medicine, but the processed film would go to Chicago for cutting, stripping, printing, binding, and distribution. Subscribers may order either the monthly *Index Medicus* from the National Library of Medicine, or the annual *Cumulated Index Medicus* from the American Medical Association, or both, as they wish.

*Subject Heading System.* Little need be said about the system of subject headings and cross-reference structure designed for use in the publication, except to note the obvious, that mechanization demands a fixed, predetermined, set approach. In actual fact, an existing subject heading authority list was completely revised and recast, and has now been published under the title *Medical Subject Headings*. The system contains about 5,000 main headings, and 67 standard, topical subheadings. It is an open-ended list, continuously scrutinized and revised, but fixed at any moment in time. It is designed explicitly for co-ordinate indexing practice; that is, no single heading, but only the conjunction of the several headings assigned, defines the true subject of the article indexed. A full explanation is to be found in the preface and introduction to the published work.

*Machines.* There are few machines specifically designed for bibliographical purposes. All those investigated for this project were built for business office use of one sort or another. Many of them are capable of adaptation, at small cost or with minor compromise, to bibliographical needs.

The imperative need was for help at the stage when all intellectual indexing

processes had been completed, when the slow and tedious alphabetizing, shingling, and numbering of the typed and proofread slips began. A high-speed mechanized camera (together with a sorter and a collator) promised to give this help, cutting the end time required to a significant degree. Entries could be photographed from cards onto a continuous roll of film, which then could be stripped into page form for printing by photolithography.

Additional problems of a subordinate nature then came into view. The matter to be photographed had to meet requirements of length, typography, ink color, and exquisitely precise placement on the card, and the cards had to be suited to the feeding mechanism of the camera, and to be punched with codes that the camera could interpret for regulating size of aperture openings.

Automatic duplication of once-typed copy was needed in order to keep proof-reading operations to a minimum. This could be accomplished by using input typewriters capable of producing perforated tape, which in turn could activate output typewriters, and possibly key punches as well. Because the needs were for single copies of author and joint author cards, and for only three or four subject cards per entry, the virtues of tape-operated typewriters designed for reproducing full pages of typescript in hundreds of copies could not be thoroughly exploited by this project. In a sense, therefore, a fairly high price would be paid for the accuracy of automatic reproduction. Moreover, while tape-operated typewriters offer steady production at high speed, the continual insertion and removal of cards and of short strips of tape results in scant saving of typing time. This situation led into a study of cards, continuous-card-feeding and card-cutting mechanisms, and tape-looping procedures.

A highly mechanized system is not necessarily the most efficient that can be devised for a given operation. The sight and sound of tab card equipment in smooth operation can have a somewhat hypnotic effect, blurring appreciation of what is involved in setting up the operation, and of what one finally gets for one's pains. Which operations call for mechanization and which combination of possible machines will prove most compatible are difficult questions to decide ahead of time. It is clear that the more thoroughly a machine operation can be planned in advance, the better. There are many ways of anticipating and working out answers to difficulties. The installation of machines carries with it a dependence on the manufacturer or distributor, whose reputation for service must be carefully investigated. A salesman's estimates of machine speed are normally given for ideal conditions, and it is advisable to discount these estimates by 50 per cent and to prepare for hard work and much follow-up in order to obtain accurate mechanical information.

NLM was fortunate in its technical consultants, whose cautions and encouragements have helped to achieve a balance between the visionary and the practical. Assistance from service bureaus in Washington and opportunities for technical conferences of all kinds on very short notice have been invaluable. They have also been repeatedly necessary.

# Photographic Equipment and Processing

THE CAMERA, as the machine which promised to reduce end time in the monthly schedule of producing the *Index Medicus*, became the dominant piece of equipment in the mechanical scheme. It did away with the burden of shingling (and the burden of transporting huge boxes of heavy twenty by twenty-four-inch page boards to the printer) without sacrificing the advantage offered by shingling. This advantage consisted in flexible, time-saving, cold-type composition on the typewriter, piece by piece and final proofreading at an early stage, piecemeal if convenient, with all entries remaining manipulatable until the last-minute check of alphabetical order. This is in contrast to the backlog problem inherent in hot-type composition of manuscript that cannot go to the printer one section at a time, but must wait for ordered arrangement of the whole to be completed *after* the cut-off date for additions, before printing, not to mention proofreading, can begin.

The principal photographic devices studied were the Varityper Corporation's Foto-List, Eastman Kodak's Listomatic and Lithoid's Composo-List camera. Only the first two were available at the beginning of the project.

The Listomatic and Foto-List both require the use of standard tabulating equipment punched cards as the vehicle for the introduction and manipulation of data in the system; the Composo-List is not tied to a card of a set dimension. In the first two systems the entry is typed onto an area at the top of a punched card and later fed into the camera which photographs the text on the cards in various desired reductions down to 50 per cent; the Composo-List system permits the text to be placed in any location for which the camera aperture has been permanently adjusted. The Foto-List handles a single line of text on the card at a speed of 120 cards (lines) per minute; the Composo-List will photograph the entire text previously imprinted on the card at the same rate of speed. The Listomatic can photograph entries ranging from one to three lines intermixed at a speed of 230 cards (up to 690 lines) per minute.

The advantage of the Foto-List revolves around the excellent quality of the finished negative and the greater ease and flexibility of accurately positioning the text on the card. The Composo-List's chief virtue resides in the availability of a

larger area of the card for text. The Listomatic, though considerably faster than the Foto-List one line system, could conceivably photograph fewer lines per minute than the Composo-List set for an aperture accommodation of seven or more lines. The paramount attribute of the Listomatic, which it alone possesses, is its ability to change the size of the camera aperture to accommodate texts of varying numbers of lines from one card to the next.

The soundest justification for the use of any of these expensive pieces of equipment (all are in the \$10,000 to \$20,000 price range) is its application to procedures that, as a basic requirement, involve the handling of relatively huge quantities of text comprising an aggregate of very short unit items; furthermore, there should be a need for one or more later generation publications, either by the updating of existing material or the provision of cumulated editions. For the smaller one-shot publication the existing traditional composition techniques such as shingling and continuous typing for photo-offset reproduction should not be ignored.

The Listomatic camera was chosen by the National Library of Medicine because it was the only one able to intermix citations of one or more lines with reasonable facility. To allow routinely three lines' worth of space for one-line or two-line entries would waste an enormous amount of page space and would result in a spotty and unattractive appearance. To settle on a fixed one-line entry, on the other hand, and to try to handle all longer entries by strings of run-over cards would soon make files excessively bulky and difficult to handle.

Once the choice of camera has been made, all other elements of the system must be brought into line. The first requirement is the utilization of a standard tabulating punched card. The space available for the imprinting of text material which is subsequently to be photographed is contained within the area shown in Figure 6. The remainder of the card, not used for text imprinting, may be used for punching purposes, except that punched codes in Column 52, corresponding to the number of lines of text imprinted on the card, must be used to trigger the appropriate opening of the camera aperture. Within the camera field entries of one, two, or three lines can be imprinted, providing the proper type size, spacing and photographic reductions are selected.

Roll film for the camera is available in three different widths, 8, 4, and 2.67 inches, and each requires a special kit to accommodate it in the camera. The cost is approximately \$120.00, \$60.00, and \$45.00, respectively, per four hundred foot roll of Listomatic film, which is panchromatic rather than the more commonly used orthochromatic film. The Listomatic design "package," consisting of the desired type size and style, the degree of reduction required, the linear length of the line, the number of lines per vertical inch, and the typewriter ratchet size, must be carefully devised for many reasons, not the least of which is the considerable cost differential resulting from the use of one of the wider film sizes where a narrower one would suffice.



These elements can be combined in a variety of ways, after the form of entry and format are determined. The top eleven-sixteenths of an inch of the punched card, excluding a border fifteen-hundredths of an inch at the top edge, is available for imprinting of text which will photograph. The entire field, however, need not be used for imprinting. Portions of the card may be consumed by punches which are needed to meet a machine sorting or collating requirement; the lateral sections of the card may not be used for text imprinting simply because the final length of line desired after reduction by the camera does not permit it. It should be noted that the camera functions symmetrically from an approximate mid-line on the punched card, photographing material equidistant on both sides. The text must, therefore, be placed precisely within the Listomatic imprinting area both vertically and horizontally. The camera reacts to any failure in meeting this rigid specification by ruthlessly chopping off the portions of text that fall outside the prescribed area.

At this point it should be explained that the size of the type selected will play a key role. The original size can be reduced by the Listomatic camera down to 45 per cent (from 1:1 down to 2.2:1, in 0.1 steps) by making the proper manual settings which can be done very easily and quickly. In order to obtain the desired reduction, it is also necessary to make special provision for synchronizing the advance of the film with the optical mechanism of the camera. This is accomplished by the use of film advance kits, which are available in sizes ranging from 6 to 14 lines per inch. The final vertical spacing after reduction is, consequently, limited to these whole numbers of lines to the inch. In the determination of the vertical length of the column to be accommodated on the page of the final printed product this information is essential. In the case of the *Index Medicus* the No. 10 Film Advance Kit is used to provide for 10 lines of text to the vertical inch.

These are the rudiments of the process of devising the various essential components of the Listomatic design package. For every different job, one or more of these elements will probably have to be changed. The interchange and resetting of parts in the camera is fairly rapidly accomplished, and the necessary kits and parts are not excessively costly.

The speed of the camera is more than ample for the NLM operation. Speed, however, must be coupled with reliability of function; the gain accruing from rapid operation is lost if the job must be run more than a single time. In this regard, the camera has not yet proved itself. This vital ability to perform routinely without significant dysfunction and subsequent rerunning has not been demonstrated by the NLM Listomatic camera to date; experience with Listomatic cameras elsewhere would, of course, be impossible for NLM to document. At the time this report was written, eight regular monthly issues of the *Index Medicus* had been filmed. Out of this number only the last issue was completed in a relatively trouble-free manner, and only after a crack team of engineers and maintenance personnel had performed an all-out investigation and overhaul prior

to its run. Significantly, most of the camera's difficulties are related to the part of the mechanism governing the variable opening of the aperture, which seems to be its most vulnerable aspect. When the camera aperture is set for the exclusive filming of one line entries, similar to the Foto-List camera, there appears to be less difficulty encountered in its operation.

During the camera's operation there is no way of determining the efficacy of its performance. There are no gauges or other instruments on the camera to alert the operator to any malfunction; this will come to light only after the film has been processed. Paper proof copy (either positive or negative), however, can be run through the camera and used to some extent as a test, but the possibility of a change in performance by the camera between the time the paper copy is filmed and the final film running should not be excluded. Ozalid copies may also be generated from the processed film, but this method has grave weaknesses as a proofreading procedure, since any errors or deficiencies brought to light in this manner would require a second consumption of film. Film is about three times as costly as paper. In the NLM operation, the original plan called for the use of paper proof copy only through the initial shakedown stages, but the erratic performance of the camera has caused this phase to be stretched beyond the first few issues.

The reliable operation of the camera must be combined with a level of film processing that will consistently yield a satisfactory product. Obviously, a poor processing job can undo perfect performance of the camera. At present, the best piece of equipment for this purpose appears to be the Oscar Fischer continuous processor, which costs around \$4,500. After investigation of the problem, the decision was made to rely on the Recordak organization for film processing rather than to do it on the NLM premises. At the time, long before the first issue of the *Index Medicus* was ready for processing, the Oscar Fischer tank closest to the Library was located in New York. Assurance was given that one would be installed in Washington shortly, but this has still not materialized. Consequently, each month it has been necessary to ship the exposed film to and from New York for processing, causing a delay in the production schedule. In addition, the quality of the processing has been uneven as evidenced by a variation in the background density of the film, despite any absence of alteration in the camera settings.

This situation illustrates one of the fundamental desiderata of a Listomatic system, namely, centralized control over a maximum number of the individual, separate operations. The exception to this rule seems to be the use of the Listomatic camera for a service-bureau type of operation, receiving for processing from other organizations material already composed and ordered on cards which are then put through the photographing operation. NLM has successfully performed several "outside" jobs of this kind. What this probably means, more precisely, is that card preparation operations should be centralized, and film processing operations should be centralized, but that the two groups of operations are separable.

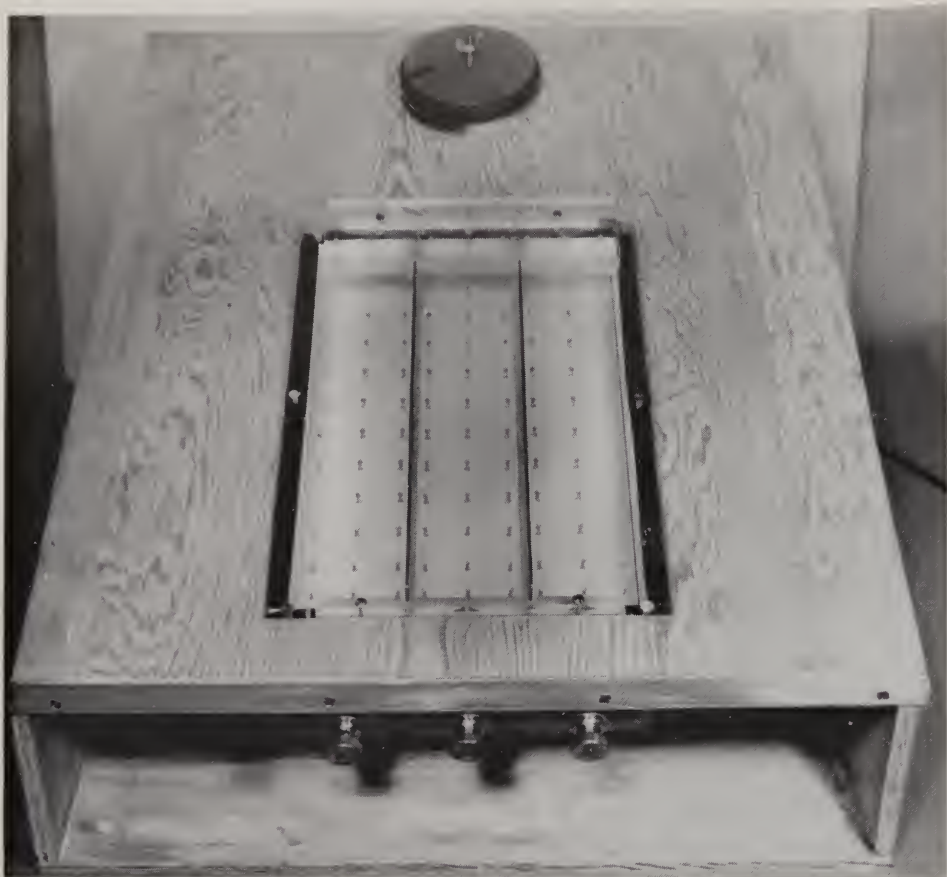


FIG. 7. Photograph of stripping box

Following processing, the finished film, in the form of rolls up to 400 feet in length, must be cut into column segments and assembled into page arrangement necessary for the further photolithographic processing. There are a number of methods available for this purpose, illustrating three general approaches; the use of "goldenrod" paper as a backing material, the use of photographic masks similarly, and direct connection of columns of film without the use of any backing material. There are advantages and disadvantages in each method. All three have been tried, and although the photographic mask method is being used for the entire first year of the *Index Medicus*, in the second year it is planned to switch to the direct method which dispenses with backing material of any kind. Instead, special light boxes are being built similar to the one illustrated in Figure 7. In the methods based on the use of a backing material, the columns of film are inserted and adhered within "windows" that are cut out of the backing material to allow for the insertion of the film. By the use of the specially designed light box,

the film strips are positioned precisely, with little effort, on a perforated plastic box, and held securely in place by a vacuum created within the box itself. Adhesive tape (Paklon) is then placed simultaneously on the contiguous edges of each pair of film strips until the page is completed; the finished page is then removed from the box by momentarily switching off the source of suction. After a minimum of opaquing, the stripped pages which comprise the issue are shipped to the printer for photo offset reproduction and binding.

A four hundred foot roll of film, representing some 135 three-column pages produced from about 21,000 cards, can be exposed, granting perfect operation of the camera, in  $1\frac{1}{2}$  hours. It requires three full rolls of film to produce the average issue of the *Index Medicus* (450 pages). To cut and strip the 450 pages requires the use of three men for about two and a half days (seven and one-half man-days).

# Composition

THE COMPOSITION or imprinting of text for the Listomatic system presents a number of special problems. One of these is the requirement of exact positioning on the tabulating card. Essential requirements for composition equipment include such things as high character density, photo-offset suitability, rugged performance, efficient maintenance service, repetitive ability, and satisfactory levels of production.

*Type Style.* Selection of suitable type faces becomes a major concern when the various factors of space utilization, printing production, and legibility must be combined in proper balance. The thin stroke, condensed (i.e., horizontally compressed) type styles, for example, require careful handling during filming, film processing, plate burning, and printing to assure good character resolution. Careless maintenance of equipment and inadequate processing generally result in filled letters, smudging, and poor resolution. The smaller compact characters create serious problems for the proofreader or the user who is called upon to scrutinize these products for long periods of time. Once the format has been devised and the dimensions of each line of type have been determined, the number of available type faces drops sharply.

Traditionally, the unit of size for type styles is stated in “points,” but this basis is not sufficiently precise for the Listomatic system. For this purpose, it is necessary that the height be determined within a small fraction of an inch, measured from the top of the tallest character to the bottom of the character possessing the lowest descender. The use of an instrument such as an optical comparator facilitates such determinations. Figure 8 shows the maximum vertical dimensions of the most commonly encountered composition machine type fonts.

*Proportional spacing.* In addition to the size of type used, there is another important economic and esthetic aspect known as proportional spacing. Basically, composition machines may be characterized typographically either as the standard monospacing types or as those using a proportional spacing system. In the former, the same number of spaces or units are allotted for all letters and numbers regardless of their relative widths. Consequently, the narrow “i” and the wide “w” occupy the same space and the linear capacity of the type font may be expressed in terms of the number of characters per unit of length. In a proportional spacing system, on the other hand, available spaces or escapements vary

Point Size	Type Style	Vertical Dimension (in inches)
14	Directory	.2055
12	Bold Face No. 1	.152
	Secretarial	.150
	Mid-Century	.1555
	Bold Face Italic	.1575
	Registry	.158
	Testimonial (Galvin*)	.162
11	Documentary	.145
10	Modern	.140
	Bold Face No. 2	.1385
	Heritage	.1415
	Registry (F2)	.1395
	Arcadia	.134
8	Copperplate Gothic (lower case)	.1045
	Text (Galvin*)	.122
	Charter (Newstype*)	.1105

\* Name used on Friden machines.

FIG. 8. Maximum vertical size of type styles available on IBM electric typewriters

with the requirements of each character and the number of characters per length unit will be governed by the specific characters included in any given sample. Generally this will result in a saving of about 10 per cent of space.

*Type differentiation.* The use of contrasting but compatible sizes and styles of type is important in a printed subject index which is made up of bibliographic citations, subject headings, subheadings, and cross references; by this simple means, the legibility of the index is enhanced substantially. This objective may be achieved by a judicious combination of roman, bold, and italic fonts in upper and lower case, along with adequate vertical spacing between lines.

*Automatic repetition.* The rather complex unit entry with its admixture of proper names, bibliographic information, and scientific terminology must be repeated several times in the *Index Medicus*. It is desirable, therefore, to find a means of automatically duplicating the entry instead of recreating it each time. For this reason, and others as well, punched paper tape composing machines such as the Friden Flexowriter and Justowriter, Remington Rand Synchro-Tape, and Underwood Data-Flo were studied.

*Programming.* The fact that it is necessary to type and also to punch several of the same elements of the entry suggested that it would be advantageous to perform one of these functions and automatically create the other as a by-product. To make such a conversion possible, the input must be provided with certain pro-

gramming instructions which can be utilized in the imprinting and punching operations.

*Positioning.* The precise requirements of the camera make it essential that the entry be positioned on the card with the highest degree of accuracy. For this purpose, various special platens and single and continuous card feeding techniques were investigated.

*Photographic reproducibility.* Imprinting on the card must be performed by means of carbon paper or carbon impregnated plastic tape ribbons that produce uniformly sharp and bold copy that will not smudge inordinately. This last requirement becomes an important consideration due to the need to pass the card many times through sorting machines which are not especially kind to the imprinted matter.

*Justification.* Right hand margin justification is a minor feature in a publication of this type; however, if it can be procured at a negligible cost in money or operational inconvenience it is a desirable addition to the rest of the system.

#### MACHINES STUDIED

Composition machines are divisible into two large groups: those which utilize punched paper tapes, and those which do not. The traditional manual typewriter and its electrical descendants are examples of machines lacking any provision for paper tape. A number of manufacturers are now producing their individual electric typewriters, some including proportional spacing features which make them suitable for cold type composition work. Their common inability to provide multiple copies of the typed entries, however, militated against their use in the project.

One interesting example of non-tape equipment investigated was the Vari-Typer with its attractive variety of type faces. Two faces are always available by turning a control knob on the machine; others may be inserted into the anvil by the typist in a relatively simple operation. Horizontal spacing of characters is variable in four increments up to an escapement of one fifty-fourth of an inch. Justification is computed automatically and leading is variable from zero to 18 points. Earlier difficulties in the use of the Model 160 to compose for the Listomatic Camera have been overcome by the more recent Model 100. This model has a specially designed card holder which accepts a standard punch card prepunched with alignment holes in columns 1 and 80 of the Hollerith design. Registration is reasonably foolproof and probably superior to that obtained from any other type of equipment. Though never considered seriously as a production machine because of its slowness of operation, the Vari-Typer was investigated for its possible use in the preparation of non-entry cards. The Model 100, however, could not be adjusted in the field to resolve the registration or leading requirements. This model can imprint only one line of type on each card; however, a multiline model appeared at the end of the project's life, too late to be tried.

Another example of non-tape equipment is the Olivetti, which has the unique feature of a replaceable carriage. Variation in typography is accomplished by transferring the carriage, with copy inserted, to another machine. Though the transfer of the carriage from one machine to another is relatively simple, its use in a large scale printing project is impracticable.

The repetitive feature of the composition work offers considerable opportunity for cost reduction in both typing and proofreading operations. There are probably three general ways in which this can be done: by either photographic or Xerographic reproduction; by the simultaneous activation of "slave" machines; by the use of a recording of the original in some form such as on punched paper tape.

Among the reproduction techniques, only the application of Xerography showed promise. The various models of the Copy-Flo camera were eliminated from further consideration primarily because of insurmountable registration and positioning problems. Card warping caused by the heat fusion process was another major deterrent. The new Haloid 914 Office Copier would appear to offer considerably more promise as a solution. Continuous punched card paper stock was reproduced on the 914, and, after bursting, the resulting cards were successfully processed through tabulating equipment. But the registration is still imperfect, and apparently cannot be improved further without redesigning the feed mechanism. The printing quality of the 12 point bold face type style reproduced on the 914 was substandard, with widespread broken and fuzzy characters.

The only equipment in this class which showed promise of transferring efficiently within the tolerances required by the Listomatic system was the IBM 938 Electrostatic Card Printer. This machine, operating at 200 cards per minute, is no longer available; precise information on its performance is lacking, but apparently serious technical problems were encountered in the high speed printing drum and the fusing process.

The Royal Robomatic, Model 330, was the only "slave" equipment actually used experimentally during the project. This equipment consists of standard typewriters connected to base units by mechanical linkage; the base units are interconnected by vacuum lines. The slave machines are controlled from a master keyboard by a simple, two-position, "print" or "non-print" key; they can also be operated independently of the master machine directly from the slave keyboard. Standard monospacing machines manufactured by other firms may be tied into the system controlled by the base units. This type of slave equipment is designed primarily for the handling of longer expository communications such as letters, where duplication in a manner simulating original composition is desirable. If it were used for relatively short bibliographic entries, the insertion and removal of cards from the various components of this system would be a major handling problem.

There are three basic types of tape composition machines: the input machines

which produce the coded tape, the output machines which are operated by the coded tape, and the combined input-output machines. All machines investigated during the project were the fully perforated "Chad" type machines equipped to handle either five, six, seven, or eight-channel tape. The current trend is toward the eight-channel tape because of its compatibility with tape-to-card converters as well as its ability to handle more complex programming signals. In oversimplified outline, five-channel tape handles numbers and a single case of letters plus certain special characters; six-channel handles both upper and lower case letters; seven-channel adds proportional spacing or code checking features; and the eight-channel, complex programming. Readers and punches may be attached directly to the machines or housed in separate control units. Special attachments available on most tape operated typewriters include Hollerith and edge-card readers, either extra punch or read units or both, plug board programmers, automatic line finders, and pin feed platens. Methods for tape correction include a delete code for characters, and a line delete code as well as a means of repunching a new tape by a combination of automatic and manually keyed operations.

One of the most versatile of all tape operated equipment is the Underwood Data-Flo System. Basic components include the Mastertyper (input), the Servotyper (output), and the Servo-Master (input-output) punch, reader, totalizer, and programmer. Two programmers are available, equipped with plug boards, one with a maximum of 88 predetermined program steps and the other with 275 steps. As many as three typewriters, two tape readers, two totalizers and a programming device can be assembled into a single system. Designed primarily for business procedures, the machines are monospacers and lack the condensed type styles desirable for the Listomatic system.

Another versatile machine of the programmatic type is the Remington Electronic Synchro-Tape Typewriter. An electric monospacing input-output machine, it may be synchronized with one or more punch and/or read electronic control units. The machine cannot be equipped with type more condensed than 16 characters to the inch.

Friden Flexowriters are manufactured in a wide variety of models operating on five, six, seven, and eight-channel tape, and available with monospacing or proportional spacing in the double case models. There are three basic units: the Recorder (input), the Reproducer (output), and the Recorder-Reproducer (input-output). Automatic type-out from punched tape is done on the Reproducer at a rate of about 100 words per minute. Additional motorized tape readers, tape punches, and card punches may be coupled to the machines. More elaborate programming is achieved through the use of the Programmatic model and the Selecta-data reader. The Programmatic is at present a monospacing machine and available type faces are not regarded as suitable for offset printing.

The Friden Justowriter is a seven-channel Flexowriter that also has the unique

# PUNCHED TAPE TYPEWRITERS

## Comparison of Principal Features and Functions

	5 Level Tape Codes	6 Level Tape Codes	7 Level Tape Codes	8 Level Tape Codes	Automatic Puncturing & Reading	Single Type Perforation	Multiple Type Perforation	Single Edge Punched	Multiple Edge Punched	Single Edge Punched Card Perforation	Multiple Edge Punched Card Perforation	Manual Typing	90 Column Tab Card Punch Attachment	80 Column Tab Card Reader	Hard Copy, Master Typewriter	Limited Copy, Slave Typewriter	Extensive Programming Facilities	Paper Tape Output for Tape-to-Card Converters	Keyboard Capacity	Control Key Capacity	Typewriter Standard Carriage Width	Optional Pto Feed Attachment	Electronic Operation	Automatic Parity Check	Optional Feature-Punch
Remington Rand Synchro-Tape Typewriter	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no	yes	yes	yes	yes	660	44	14	13"	yes	yes	yes
Friden Flexowriter Model FI,	no	yes	no	no	no	yes	no	no	no	yes	no	no	no	yes	no	yes	no	no	572	42	6	12"	yes	no	no
Friden Flexowriter Model FC	yes	no	no	no	yes	no	no	no	no	yes	no	no	no	yes	no	yes	no	no	572	26	4	12"	D	yes	no
Friden Flexowriter Model FG	yes	yes	no	no	yes	no	no	no	no	yes	no	no	no	yes	no	yes	no	no	572	42	8	12"	yes	no	no
Friden Flexowriter Model FPC5	yes	no	no	no	yes	yes	yes	no	no	yes	no	no	no	yes	no	yes	no	no	572	42	8	12"	yes	no	no
Friden Flexowriter Model FPC8	no	no	yes	no	yes	yes	yes	no	no	yes	no	no	no	yes	no	yes	no	no	572	42	8	12"	yes	no	no
Friden Programmatic Flexowriter Model FPC5	yes	no	no	no	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes	no	yes	no	572	42	8	12"	yes	no	yes
Friden Programmatic Flexowriter Model FPC8	no	no	yes	no	yes	yes	yes	yes	yes	yes	yes	no	no	no	yes	no	yes	no	572	42	8	12"	yes	no	yes
Friden Programmatic Flexowriter Model FTCB8	no	no	yes	no	yes	yes	yes	yes	yes	yes	yes	no	yes	no	no	yes	no	no	572	42	8	12"	yes	no	yes
Friden Computer	yes	no	yes	no	yes	yes	yes	yes	yes	yes	yes	no	yes	no	no	yes	no	no	572	42	8	12"	yes	no	yes
Friden Justewriter	no	no	yes	no	yes	yes	yes	yes	yes	yes	yes	no	no	yes	no	yes	no	no	572	42	8	12"	yes	no	yes
Friden Flexowriter Model FTM (Special)	no	yes	no	no	yes	no	no	no	no	yes	no	no	no	yes	no	yes	no	no	572	42	6	12"	yes	yes	no
IBM Type 884	no	no	no	no	yes	yes	yes	no	no	no	yes	no	no	yes	yes	no	no	no	572	42	6	12"	yes	yes	no
IBM Cardatype	no	no	yes	no	yes	no	no	no	no	no	yes	no	no	yes	no	yes	no	no	—	42	—	12"	S	yes	no
Teletypewriter	yes	no	no	no	yes	no	no	no	no	yes	no	yes	yes	no	yes	no	yes	no	—	42	—	12"	yes	no	yes
Teletypesetter	no	yes	no	no	yes	no	no	no	no	yes	no	no	no	yes	no	yes	no	no	360 plus	26	—	8 1/2"	D	yes	no
Underwood Datado	yes	yes	yes	no	yes	yes	yes	yes	yes	yes	yes	no	no	yes	yes	no	yes	no	360 plus	60	—	8 1/2"	D	yes	no
	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes	yes	no	yes	no	572	43	—	12"	yes	yes	no

Fig. 9. Comparison of principal features and functions of punched tape typewriters

and fascinating ability of automatically justifying the right hand margins of the material typed on the Recorder. Eleven type faces ranging in size from 8 to 14 point are available on the Reproducer in escapements of  $\frac{1}{32}$ ,  $\frac{1}{36}$ , or  $\frac{1}{48}$  inch. The Recorder and Recorder-Reproducer machines are limited to eight type faces from 10 to 14 point with the single escapement of  $\frac{1}{32}$  inch. The maximum line which may be justified is six inches with  $\frac{1}{48}$  escapement, eight inches with  $\frac{1}{36}$  escapement and nine inches with  $\frac{1}{32}$  escapement. The  $\frac{1}{48}$  escapement is available only with 8 point Newtype or Galvin, the  $\frac{1}{36}$  with 10 point Book Type only. Optional equipment includes automatic line finders, pin feed platens, and edge punch attachments. Limited programming for auxiliary equipment such as the tape-to-card converter is feasible; however, a converter similar to the Systematic C749 would probably be necessary for efficient operation.

The characteristics of each composition system are spelled out in specific detail for comparison purposes in Figure 9. This will serve also to illustrate the complex nature of the problem encountered in choosing the most suitable equipment. What is needed is a composite of the machines which combines the strong programming features offered by one with the desired typographic characteristics of another. To the best of our knowledge such a device does not exist. The Friden machines come closest to fulfilling the manifold requirements of the *Index Medicus* system. The choice finally narrowed down to the eight-channel Flexowriters and the seven-channel Justowriters. Because the Justowriters offered the additional dividend of right hand margin justification without any perceptible drawbacks, this machine was finally chosen. The model "AA," equipped with 12 point bold face type and an edge punch reader and punch, was selected as the input machine, and the model "JU," equipped with 8 point Galvin type ( $\frac{1}{48}$  inch escapement) and the clamp type platen, was selected for output imprinting.

The use of separate input and output machines is essential for several reasons. First, automatic justification can be accomplished only through a two phase cycle consisting of an input step in which justification codes are included in the generated punched tapes; in the second phase these codes are read by an output machine equipped for this function. Second, even if no attempt is made to obtain justification, the need remains for a standard platen to prepare proof copy in the input phase, whereas for the final tabulating card product only a card-holding platen will do. In any event, the total number of machines required will remain about the same if they are all alike or if they are not.

#### SPECIAL PROBLEMS

*Positioning.* Positioning and registration requirements for the Listomatic Camera are so critical that few of the currently available devices are capable of fulfilling this function satisfactorily. For this purpose there are two basic methods in use, each with its own advantages and disadvantages. Entries may be im-

printed either on individual pre-cut card stock, or on continuous form stock which requires subsequent die-cutting or bursting.

Uncut continuous card stock is used with the assistance of a pin-feed platen and an Automatic Line Finder. The latter device is expensive, and, judging from reports received from installations elsewhere where these devices are in use, they are not as dependable as would be desired. The card stock proper may be in one of two forms, either completely unprepared for conversion to card dimensions or pre-scored for machine bursting. In the former case, a very expensive Card Cutter (about \$7,000) is available to die cut the cards rapidly and accurately; however, there is considerable evidence which indicates that cards are sometimes cut improperly with serious consequences later in the machine operations. The other type of card stock can also be used with a continuous form feed mechanism and subsequently snapped out manually or by a machine costing around \$2,000. The consensus on this technique in a Listomatic operation is unfavorable—the drawbacks being the flimsy nature of the partially cut stock, the generation of paper debris during bursting, and mechanical difficulties of the bursting machine.

In those systems which do not utilize a continuous form, but require the insertion of individual cards for imprinting, two methods are available for card holding. The first, and probably the better of the two, is the system used on the Vari-Typer. Each card has two pre-punched holes, a round hole in Column 1 (Hollerith) and a square hole in Column 79 and 80. The card is dropped into the slot on the Varityper, slid into position and locked into place by lever-activated pins which position the card. Unfortunately, this device can be used only with the Varityper. Despite the loss of the three columns consumed by the registration holes, this method is still very attractive.

The second method involves the use of one of several platens collectively designated as "card holding." The most satisfactory platen (and the one used in the *Index Medicus* system) is made by IBM and costs about \$75.00; however, the cost of the platen installed on the Justowriter is approximately \$375. This platen contains a slot along its horizontal axis which opens to receive the card and then clamps it firmly in position for imprinting when released by the operator.

The decision was made to use the clamp-type platen rather than a continuous form feed mechanism. A better solution to the card feeding and positioning problem would be worth a lot to the project, but in view of the inadequacies of the continuous feed methods, the cheaper, more reliable, more accurate card-holding platen appears to be the best buy.

*Ribbons.* The great number of times that the imprinted cards have to be manipulated in and out of a variety of machines and storage points made it imperative that smudging of text be reduced to a minimum. Many different ribbons were tried and subjected to naked eye and camera testing. Sample cards typed with each of the ribbons were prepared and then passed through the tabulating





machines and Listomatic Camera many times; in addition, cards were sprayed with an application of clear Krylon plastic and similarly tested. Smudging from the carbon ribbons has been a serious problem in machine operations. The 12 point bold type with its heavier carbon deposition, used for non-entry heading cards, created the greatest problem. The collator rolls would remove small lumps of carbon from the typed cards and deposit them elsewhere on the card or on other cards. Light spraying with Krylon seemed to have little effect; indeed, the condition deteriorated further if the cards were run the same day. The most successful method has been to spray lightly with Krylon and allow the cards to dry over night exposed to the air. Fortunately, neither the relatively thin stroke 12 point bold face italic type used for subheading cards and running heads nor the 8 point Galvin used for entires requires this laborious prophylactic care.

Another problem which came to light during the period of experimentation with ribbons pertained to the detrimental effects of the accumulation of static electricity. Of the three principal materials currently used for non-cloth ribbons—mylar, acetate, and paper—the last is the most resistant to static; unfortunately, it is also too weak a material to perform properly at the higher speeds of tape activated typewriters. As for the other two materials, apparently only mylar can be manufactured static free, but it is also considerably more expensive.

*Entry duplication.* The output imprinting operation has proved to be one of the disappointing features of the new system because of the inordinate amount of manual handling of cards and tapes that is required. The double reader and limited programming features of the Justowriter are responsible for the complications of tape handling; furthermore, the relatively short lengths of tape make them unsuitable for the use of a looping technique. After much trial and error, it was reluctantly concluded that the best method would be to remove and re-insert the tapes as needed.

*Justification.* Although the Model "AA" Justowriter is called a "Recorder-Reproducer," only semiautomatic justification can be performed on this machine. This is done through the use of a "space prompter switch." In this operation a proof copy and punched paper tape are produced initially in the input phase. After each line is typed the number of units to be added or subtracted is determined by visual inspection of a scale on the typewriter. Spacing changes are indicated which then serve as a guide in producing justified copy by a combined tape and manual process. The "JU" Model, on the other hand, does this at a much higher rate of speed; the dual reader mechanism which is required for this task cannot be installed on the Model "AA."

The esthetic appearance of the index has, on the whole, been enhanced by the use of Justowriters; occasionally, some undesirable compression has resulted. Conflicting statements have been made about the relative loss or gain of space which results from the Justowriters. Effective utilization of space is probably more a function of operator skill than machine capabilities. Though the machine

is capable of contracting a line within very prescribed limits, most lines are actually expanded. Any significant gain or loss of space would be very difficult to ascribe solely to automatic justification. In an index which consists entirely of short bibliographic entries, justification is essentially a luxury which should be sought only if it is obtainable free and clear without any significant sacrifice made elsewhere.

*Diacritical marks.* With the change in format which eliminated the original foreign language journal article title the use of diacritical marks was abandoned. Because of limitations on the total number of characters available on these machines, the choice lay between a limited number of Greek characters and a limited number of diacritical marks. Space considerations alone were sufficient to warrant deciding in favor of the Greek characters.

*Runovers.* Because of the inevitable excessive length of the occasional bibliographical entry (for example, there may on occasion be as many as 15 authors of a single article), it is not feasible to design the citation in such a way as to limit it at all times to a maximum of three lines. In the Listomatic system, all entries consisting of more than three lines require an additional trailer or "runover" card; a seven line entry (and they are occasionally encountered) will require two "runover" cards, and so on (Figure 10).

Early in the project it was estimated that the form of entry adopted would yield the "unacceptably high" level of 10 per cent runovers. The entry was redesigned to permit a maximum of 5 per cent runovers; for various reasons, however, this did not materialize. Instead, it was found that the level of runovers for the first ten months ran consistently around 13 per cent. Although the additional cards add substantially to the total work load it was a pleasant surprise to find that they could be accommodated in the system without strain.

*Other Problems.* The output machines have presented various mechanical problems, especially in connection with the clamp-type platens. Though adjusted at the factory the card position could be varied by touching a release button on the platen roll. The immediate solution was to remove the button.

Problems encountered with tilted copy were traced to training deficiencies on the part of the operators, who had been taught how to insert cards at an installation where a slightly different platen was used. Retraining took care of this difficulty.

Other platen registration problems were due to the loosening of set screws as a result of machine vibration. The acquisition of special wrenches and the institution of a program of daily tightening of the screws has eliminated this sore spot.

More serious was the jamming of the ribbon feed mechanism stemming from the static-laden ribbons that were used. The introduction of the new static free ribbons eradicated a variety of typographic ailments whose origins were attributable to this source.

## Punched Card Preparation

THE LISTOMATIC'S use of a punched card as a vehicle suggested the possibility that this could provide a solution, also, to the Herculean sorting problem. The interfiling of approximately 25,000 to 30,000 subject and 15,000 author entry cards each month involves a prodigious expenditure of time and manpower at the end of the operation where it ill can be afforded. It is an important factor in the effort to achieve the greatest currency, since the time required for the arrangement of cards for publication has a direct relationship to the final promptness of publication; this is even more applicable to the annual cumulation. The coding potential of the punched card has a number of facets, all basically the same. Various combinations of one or more holes which are punched into the card represent specific numerical or alphabetical characters which are recognized and manipulated by the various tabulating card machines, the sorters and collators.

The two punched card coding systems which are most widely used in this country are those designed for the equipment manufactured by the International Business Machines Corporation and Remington Rand. The advantages and disadvantages of the card design and machine capabilities in each system were studied with conclusive results. The IBM card is divided into 80 columns extending from the top of the card to the bottom; the Remington Rand card consists of two almost equal fields of 45 columns, horizontally divided, but because the imprinted text occupies a substantial portion of the top of the card, a sizeable amount of card space is lost. In the IBM card this lost space precludes any alphabetical punching in the center portion of the card, since the zone punches which convert the numerical codes to alphabetical codes in this system are located in the same area. The arrangement of fields on the Remington Rand card, however, allows alphabetical punching throughout the entire lower forty-five column field. In an application where the maximum line length available on the card coupled with substantial code punching is required, the Remington Rand card has attractive advantages.

In addition, the Remington Rand equipment has other commendable attributes. The Electronic Sorter is operated by a photoelectric cell instead of by means of brushes which have tendency to smudge and scratch the cards as they pass through; the collator is able to perform a sequence check from either the primary

or secondary feed during a simultaneous matching and merging operation; the keypunch can also double as a verifier. Unfortunately, two essential functions cannot be obtained with Remington Rand tabulating equipment, namely, alphabetical collating and automatic designation of column length. Consequently, the Remington Rand system was eliminated and attention was directed to the IBM data processing equipment.

### CARD DESIGN

During the early stages of the project, there were four requirements to be met in designing the punched card on which the entry is imprinted. The first aspect dealt with the area reserved for the typing of the entry, called the Listomatic imprinting area; the derivation of this field was described in the previous chapter. The second requirement pertained to the assignment of fields to be reserved for codes used in the bibliographic retrieval phase of the new system; since this phase failed to materialize, the entire area below the Listomatic imprinting area, roughly from Columns 22 to 51, remained unused. The third need was simply to provide for the appropriate opening of the Listomatic camera aperture to encompass one, two or three line entries. This consists of a single punch in the "3" position in Column 52 for a two line entry, a "3" and "4" punch in the same column for a three line entry and no punches for the single line entry. The fourth and largest requirement involves alphabetical and numerical punching as filing indicia to permit the sorting and arranging of the cards by machine for publication purposes. Figure 11 illustrates the four areas referred to above; the detailed card design appears in Figure 21 in the next chapter.

The *Index Medicus* format consists of separate author and subject sections, each with its special arrangement; the sorting and punching of author cards is, therefore, based on a different approach from the one used for the sorting and punching of subject cards. The design of the author cards is a straightforward matter involving the provision of alphabetical punching of the surname and initial; the structure of the subject cards is considerably more complicated.

For the subject cards numerical codes are used for the subject heading and standard subheading. Since there are approximately 5,000 subject headings in the system, it would appear that a four digit code will be ample; in order, however, to provide a satisfactory cushion for future interpolation of added and changed headings it was decided to use five digits. A special code checking process, which will be explained later, adds a sixth digit to the subject heading code. By similar reasoning, the 67 subheadings are provided with three digit codes plus a fourth for the check digit. To provide for the further grouping of entries under each subject heading and heading-subheading combination, a numerical code for the first letter of the senior or sole author's surname is used. Codes for the language and year of publication of the indexed article and a special designation for review articles were originally provided but later abandoned. To provide a



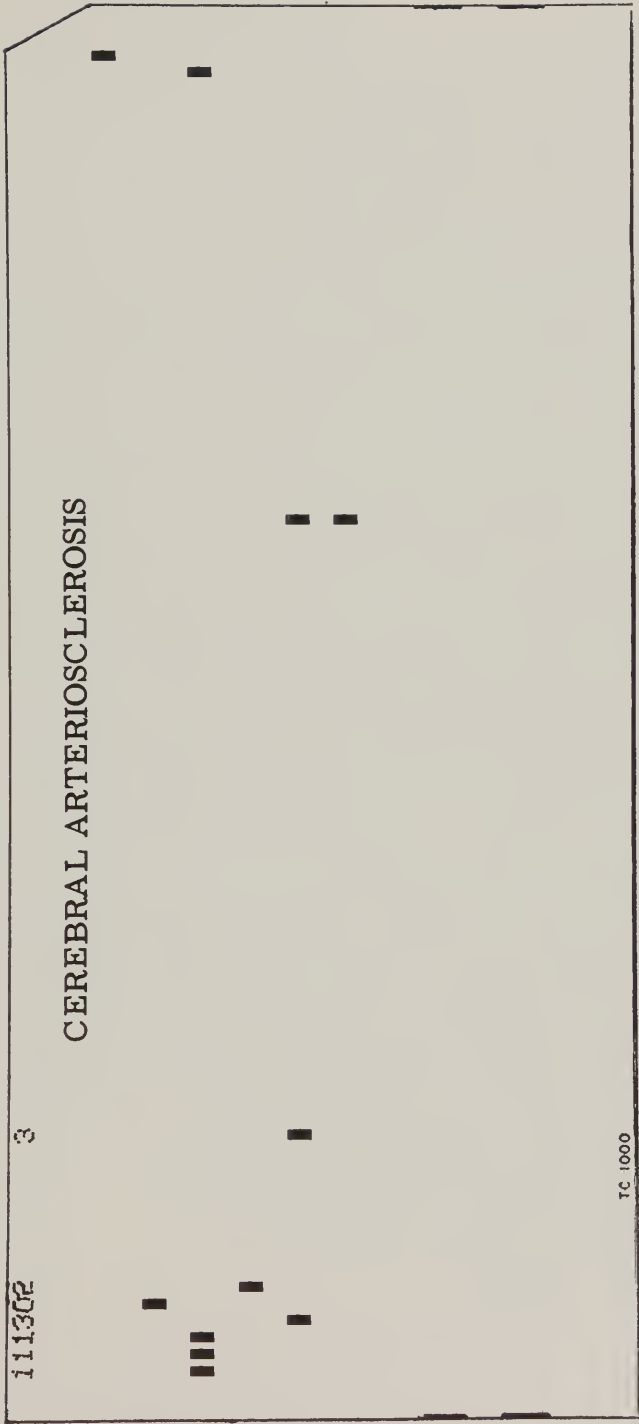


FIG. 12. Non-entry mainheading card

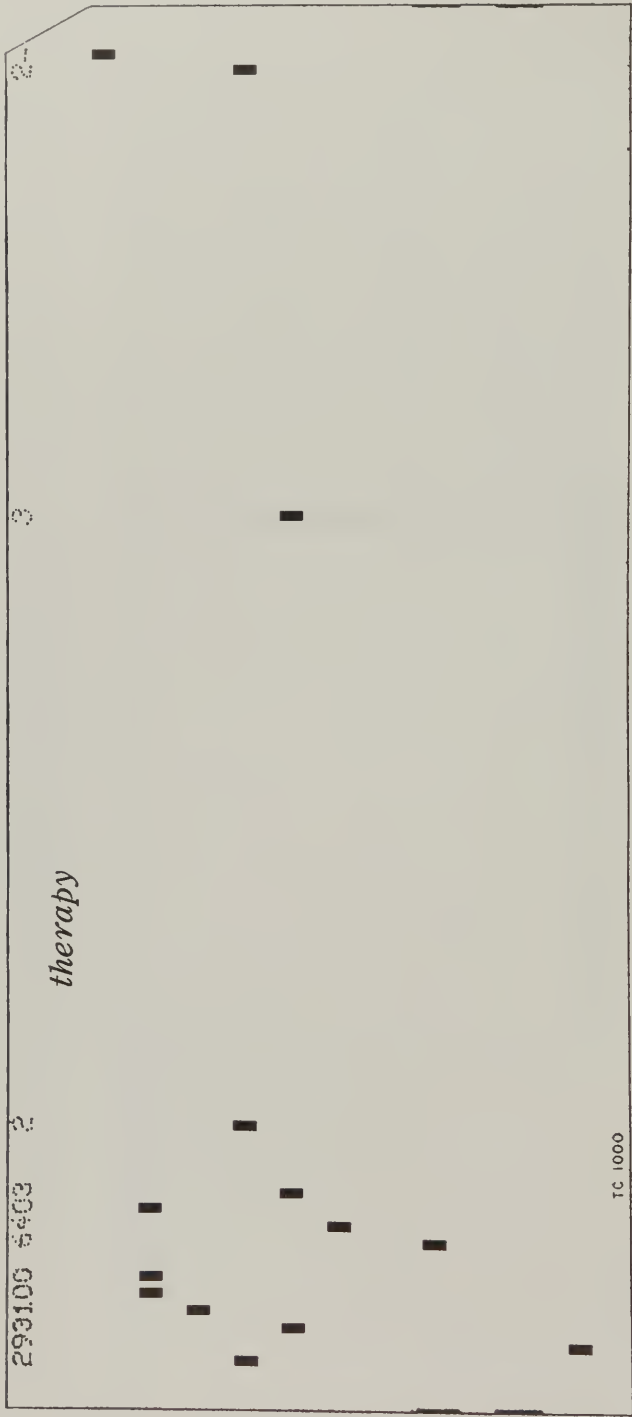


Fig. 13. Non-entry subheading card

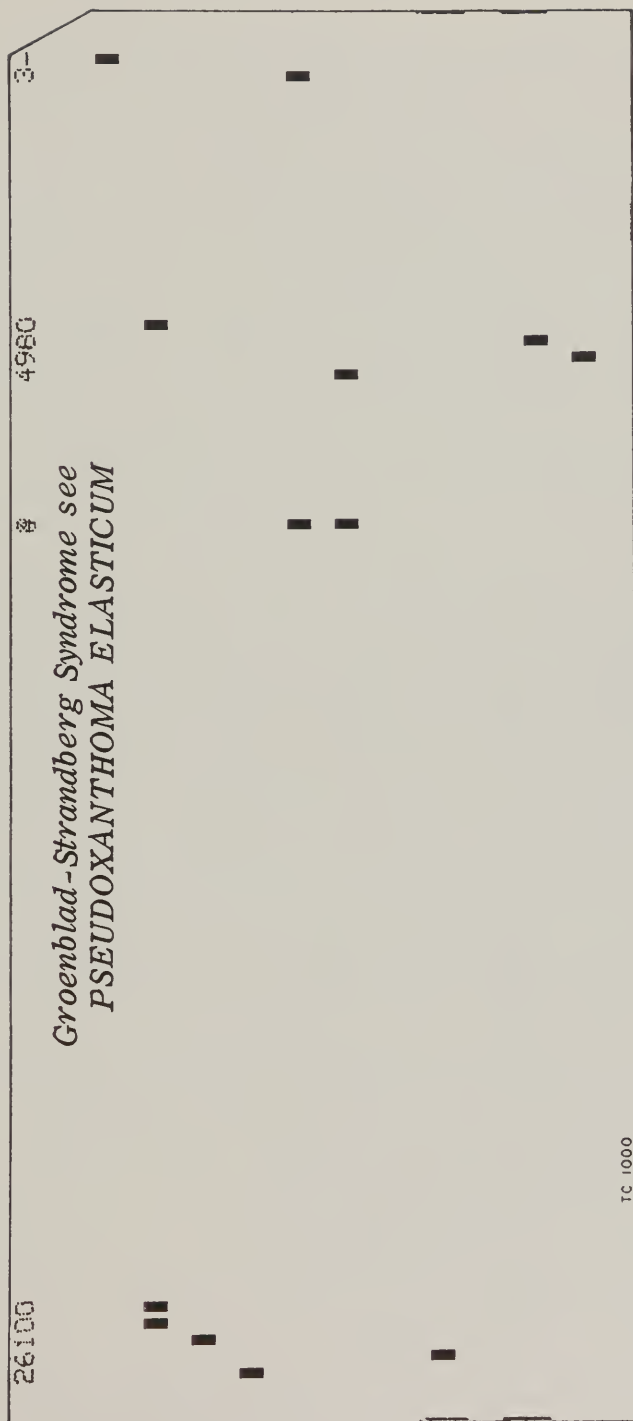


Fig. 14. Non-entry "See" reference card

02300

see also ANGIONEUROTIC EDEMA

ALLERGY

03690

4-

TC 1000

means of identifying the final product by the originating individual, numbers assigned to members of the indexing staff are also punched into the card.

*Non-entry Cards.* In addition to the entry cards, the non-entry cards must be punched in a manner that will provide for full and harmonious integration of both types of cards into a homogeneous system. There are four types of non-entry cards: main subject headings, subheadings, "see" and "see also" cross references (Figures 12-15). For the main heading the card is punched with the six digit code for the subject heading; the subheading card is actually a main heading and subheading combination with both elements punched into the card. The "see" and "see also" cross references are both punched on two axes: the term referred to, and the term referred from. This is necessary in order to permit the machine to select first the cross references needed in any given month, and then to arrange them in publication order. Appropriate punching in column 52 to control the Listomatic camera aperture provides the desired leading above and below the text on the non-entry cards.

#### KEYPUNCHING

The actual punching of the entry cards can be performed by one of three general methods: direct manual keypunching, use of a mechanical tape-to-card converter, or a cable connecting a keypunch directly to the composition machine. All three methods were investigated with the first being the one finally adopted.

*Cable-connected keypunch.* There were economic objections to the provision of one or more separate keypunches for each input composition machine, because the intrinsic nature of this operation in the *Index Medicus* system is not a 1:1 relationship between typewriters and keypunches. The fact is that the greater part of the input (title and bibliographic reference) is composed for the visible entry but is not punched; likewise, there is also a portion of the input (subject headings and subheadings) which is required for punching but not for the visible entry. This is an impasse which militates against the use of cable-connected punches.

*Tape-card conversion.* The prospect of exploiting the full input punched tape to generate the punched and imprinted card was a challenge into which much of the project investigators' energies were channelled. The problem of programming tapes to operate both a reproducing composition machine and a tape-to-card converter proved to be a complex one. The IBM 046 Tape-to-Card Converter, which punches cards activated by either five or eight channel tape codes, showed considerable promise in the beginning, but the available input machines did not possess the necessary controls for programming as many variables as are needed. As an alternative, it is necessary to combine the tape-activated punching with direct manual keying, and this the 046 is unable to do in a single card cycle. Another deficiency of this machine for NLM purposes is its awkwardness in handling short lengths of tape rather than the long runs for which

the machine was designed. Efficient repetitive manipulation of short tape sections, apart from the manual awkwardness of tape insertion and withdrawal, requires the use of an Alternate Program Device and this attachment cannot be installed on the 046 Converter.

*Direct keypunching.* In addition to the regular characteristics of the keypunch, the IBM 026 Printing Punch, as its name indicates, simultaneously interprets and prints the characters across the top of the card. Fortunately, this "interpreting" is accomplished in a location entirely outside of the Listomatic imprinting area; consequently, this useful visible information can be provided without any risk of its being included in the exposed film. Another advantage derived from the use of the 026 is its ability to print directly above the column punched, thereby clearly identifying visually the codes punched in each column.

Two valuable accessory devices on the keypunch are the Alternate Program Device and the Self-Checking Number Device. The former provides for the different sets of program instructions that are required for the author and subject cards; these program functions include automatic skipping, duplication, and keyboard shifting. The Self-Checking Number Device is intended to eliminate the need for one phase of the proofreading of the punched cards by providing a built-in method of verifying the numerical subject codes. This is done as follows: to the regular numerical code for the subject heading and subheading an additional check digit, mathematically predetermined, is added. If, in the course of the operation, the number has been correctly punched, the machine automatically inserts an "x" punch in column 81; if, however, an error has been committed, the keyboard locks, a red warning light appears, and it is necessary to depress a special key to clear the defective card. The device is quite accurate in operation, but is subject to the same frailties to which all machines are heir.

A portable punch proved to be a useful adjunct to be used on occasion to supply punches without requiring that the cards be returned to a keypunch. The machine has a sliding index tray and is entirely manually operated; a maximum of six visually verifiable digits may be punched at one time. Other similar devices are available that have a greater capacity.

#### TABULATING EQUIPMENT

For the purpose of arranging the imprinted and coded entry and non-entry cards into proper sequence, two classes of tabulating machines are used, sorters and collators. These machines are sufficiently well known not to require further description beyond noting that sorters can distribute a single deck of cards into as many as 13 pockets whereas collators have the ability to match, merge, and select cards from two decks simultaneously.

*Sorters.* Five of the IBM Sorters and related machines were investigated: the 082, 083, and 084 Sorters, the 101 Electronic Statistical Machine, and the 108

Card Proving Machine, but only the first two were used experimentally in the Library. A sixth machine, the 080 Sorter, an early model rather limited in its capabilities, was studied briefly and dropped from further consideration.

The 082 Sorter, operating at the rate of 650 card passes per minute, was found to be unsatisfactory because of the destructive effects of card jams. As many as seven or eight cards were reprinted and repunched whenever a card jam occurred. It was, also, too slow a machine for the quantity of cards generated for the *Index Medicus* system and the time available for their sorting.

The 083 Sorter, operating at the rate of 1,000 card passes per minute has proved to be a highly efficient machine. Engineering improvements stop the machine almost always on the card that jams, and jams occur less frequently than with the 082. Special features installed on the 083 Sorter include the Alphabetical Sorting Device, the Multiple Column Selector, Length of Field, and Zero Elimination Devices. Normally, alphabetic sorting requires two card passes per column; with the Alphabetical Sorting Device, the letters A, C, E, G, I, L, Q, R, U & X require only one pass and the remaining 16 letters, two passes. The result is that alphabetic sorting with this device requires one and two-thirds passes per column.

Multiple column selection permits reading on ten columns for certain functions; for instance, all cards relating to a specific subject concept can be pulled out of an unarranged subject file or a specific author can be pulled out of the unarranged author file.

The Length of Field device is used during assembly of the Author Section. By first arranging authors in groups according to the length of name, sorting requirements are reduced by approximately half.

The Zero Elimination Device performs a function during numerical sorting similar to the Length of Field Device in alphabetical sorting in that numbers containing all zero's to the left require no further sorting.

In operation, it has been difficult to achieve a speed in excess of 750 card passes per minute because of the need to stop the machine to unload full pockets. Theoretically, it is possible, but experience here and at other data processing centers indicates that the rated speed cannot be maintained over longer runs.

The 084 Sorter, which made its appearance quite recently, has a number of advantages. The hopper is a high capacity automatic juggler type, and the brush sensing mechanism has been replaced by a photocell reader. Another important improvement is the high capacity radial stacker, which eliminates the need for stopping during unloading.

*Collator.* The 087 Alphabetical Collator, operating at a rate of 240 cards per minute, is also equipped with a Code Accumulating Device and two Cycle Dealy Units. The Code Accumulating Device may be set for any number of lines from 1 to 999 by a simple wiring change on the control panel. The predetermined total

number of lines per column is counted from the Listomatic codes in column 52; this number may be exceeded by one or two depending on the situation of the last two cards counted. For example, if the next to last card brought the total to 99, a one line card would yield 100 lines, a two line 101, and a three 102. The Cycle Delay Unit prevents the termination of a column with certain undesirable non-entry cards such as main headings or subheadings. In operation, a control punch transfers the collator feed so that the prescribed terminal card will be delayed and subsequently fed at the proper time to begin the succeeding column. This rejection feature will result in a varying minus count from 97 to 99 lines per column. The procedure has been tried experimentally with success, but has not yet been incorporated into the regular publication system.

A number of problems have arisen with the collator. The Code Accumulating Device has performed erratically at times, and, unfortunately, the results are not evident until after the film has been processed; the feed rolls pick up ink from the cards and transfer them elsewhere on the card or on following cards; an oil reservoir will smudge cards on the initial run in; the machine is more prone to card jams than the sorter. The ink smudging problem has been controlled to a satisfactory degree by selective spraying with Krylon and air exposure, and oil smudging has been eliminated by running waste cards prior to an actual operation until the condition clears.

Less than one year ago IBM also introduced a new collator, the 088 Numerical Collator. This machine has a speed of 650 cards per minute, more than twice the speed of the other alphabetical or numerical models. Loaders, stackers, and sensing mechanism are similar to those of the 084 Sorter. The substantial price differential between the 088 and the 087 (almost twice the rental charge) was one strong argument against the adoption of the newer machine, but it was not the only one. For example, IBM could not definitely guarantee that the essential Code Accumulating Device could be attached to the 088.

Finally, another interesting piece of card sorting equipment, operating on different principles, was investigated. This machine, called the Keytronic Sorter, requires no punching of cards, nor are the dimensions of the items to be filed by means of this device sharply circumscribed. In operation, cards are successively and visually inspected by the operator, who then depresses the proper alphabetical or numerical key which actuates the mechanism to move the card to its proper bin. The device was regarded as unsuitable for use in the *Index Medicus* system.

## The New *Index Medicus* System

AN ACCOUNT of the indexing system, step by step and stage by stage, will show the itinerary of the journal piece from its receipt in the Library until it is released to the Library stacks, and the preparation of the index entries from the first contribution of the indexer to the final examination of the stripped film. Various ways of arranging the flow of work into a smoothly functioning system have been considered. Figure 16 is a graphic representation of the general outlines of the system developed during the project which is now in actual use for the preparation of the *Index Medicus* and the *Cumulated Index Medicus*. The following work stations comprise the phases of the *Index Medicus* system, exclusive of the machine operations involving card manipulation, filming, and page assembly:

1. Indexing and revision
2. Indexing assistant
3. Input typing
4. Proofreading
5. Key punching
6. Output imprinting
7. Inspection and storage.

*Indexing and revision.* After being recorded in the Library's Serial Record, the journals selected for *Index Medicus* indexing are ready to be distributed to the indexing staff. As a result of delivery conditions, the journal receipts vary widely from day to day. Of approximately 1,700 titles indexed in the *Index Medicus* an average of about 250 individual issues are received each week or about 50 pieces per day. The range fluctuates, however, between 20 and 105, creating some difficulties in the attempt to maintain a zero backlog.

The indexer scans contents of journals, selects the substantive articles, assigns subjects and subheadings to these articles, transliterates non-Roman author names, and translates all foreign language titles. The indexer types on a data sheet for each article the transliterated author name and translated title if called for, the standard abbreviation for the original language, the pagination, and the subjects and subheadings, and indicates on the data sheet or in the journal itself any peculiarities of name or title that require special attention at a later stage. The data sheet is then clipped to the first page of each article.

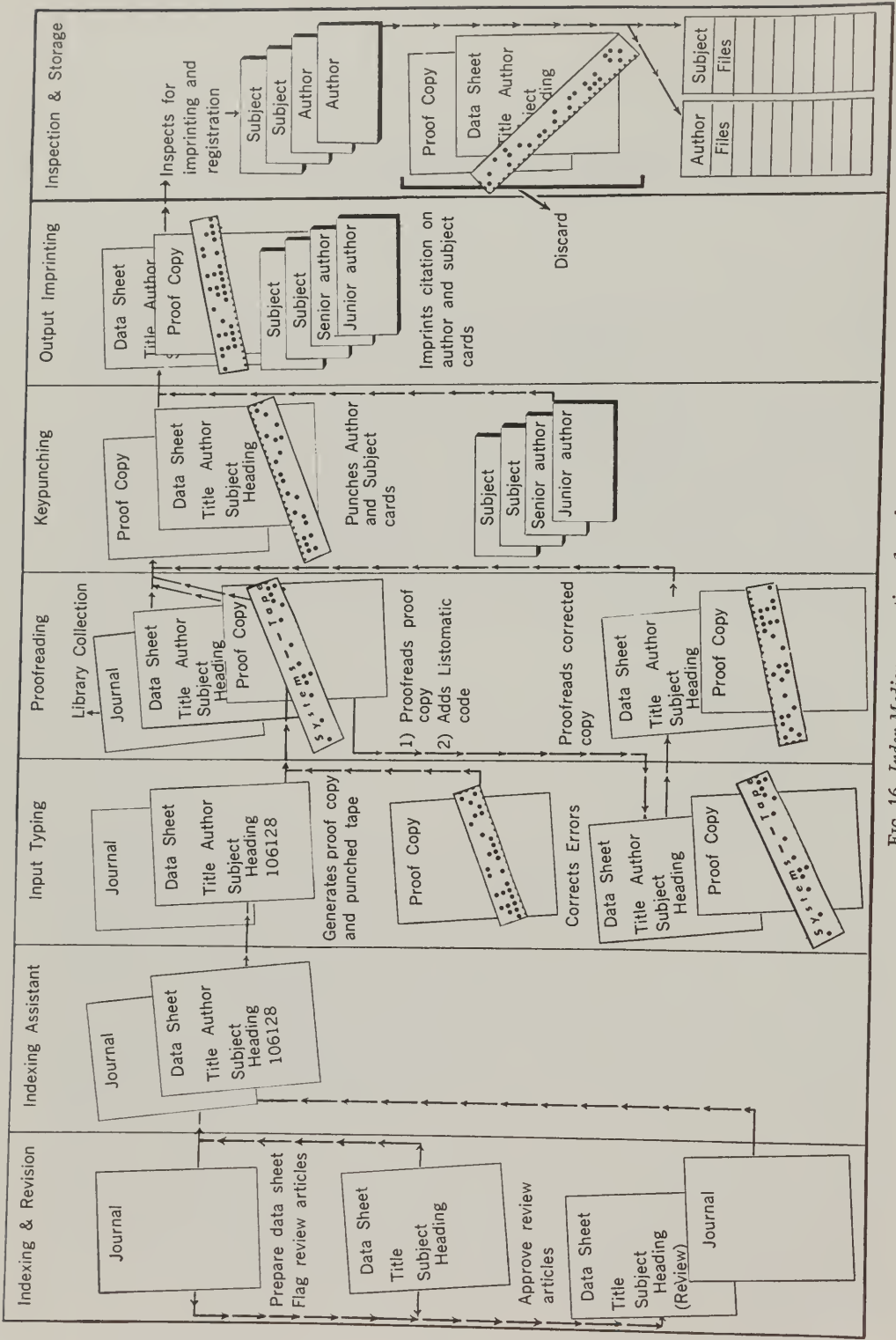


FIG. 16. *Index Medicus* operations flow chart

Various contributions to other divisions of the Library, or to bibliographical projects in other libraries, are made by the indexers in the course of their scanning. These incidental extras include making cards for portraits, using pink data sheets for articles to be considered for inclusion in the *Bibliography of Medical Reviews*, and preparing contributions for the *East European Accessions Index* and the *Monthly Index of Russian Accessions*.

The completed work is inspected daily with selected portions being sent to the revisers and the remaining acceptable work going to the Indexing Assistant station.

*Indexing Assistant.* The indexing assistant's prime function is to conserve the valuable time of the indexer by supplying the descriptive data and machine codes. The code numbers for main headings and subheadings are derived from a code book. A two-digit code for the initial letter of the senior author's surname is also supplied. In the beginning, code numbers were given also for language, year, and review article indication, but this is no longer done, because storage of the cards for other uses is not now contemplated, and after publication of the annual cumulation the cards will be discarded.

In order to minimize errors and to lessen the burden of proofreading, a file of journal title abbreviations is kept on edge-punched cards. (These are cards which bear the usual paper tape code punched along one margin.) Before the first issue of any journal is indexed, the correct standard abbreviation for its title is determined and is edge-punched on a card for this file. Thereafter the abbreviation can be automatically transferred from punched card to perforated tape without danger of typographical mistakes in copying. At the point when a journal issue with the indexer's data sheets is ready to move from the Indexing Assistant Station to the input typist, a tape is prepared giving the abbreviation, with the volume number and date for the piece added (and checked), leaving pagination the only part of the individual citation that requires attention on the part of typist and proofreader. Approximately 300 articles are processed in one day by each indexing assistant.

*Input Typing.* The journals with their data sheets and journal reference line tapes next move to a typist who makes a proof copy and, simultaneously, the coded paper tape on a 12 point Justewriter Model "AA." The hard copy will be used to proofread the tape, which will serve as a recording to be used later for imprinting the entry repetitively. The journal reference line tape is inserted into the reader of the Justewriter and the typing of the material commences in the following sequence:

1. Senior author name
2. Junior author name
3. Title of article
4. Reference line
5. "See" references from a junior author to the senior author

The tab stops are set for an approximately  $5\frac{1}{8}$  inch line. After the typing of the authors and the title, the reference line is added semiautomatically from the journal reference line tape which has been programmed to stop after the journal title abbreviation and volume number to permit manual keyboarding of the pagination, with the remainder of the reference line run in automatically. The language abbreviation for the tape, if needed, is added. Programming requirements consisting of a J-carriage return, a stop code, and a second J-carriage return complete the encoded unit citation. A light on the front of the typewriter warns the operator that the zone of justification has been reached. Each line must be ended and the J-carriage button depressed before the zone has been traversed. If this is not done, the light goes out and the line will not justify.

Each junior author cross reference in a multiple author citation is separately typed and encoded in the unit citation tape along with suitable program instructions.

Runover entries (i.e., those exceeding 3 lines) require distinctive programming to permit card removal and insertion during output typing.

An average day's output for each typist comprises about 125 articles; the total daily potential for the six "AA" Justowriters is, therefore, about 750 articles.

*Proofreading.* The tape, proof copy, data sheet and journal are next transported to the proofreaders. It should be noted that, although the hard copy is in a 12 point type size to facilitate proofreading, the publication version will be in 8 point, but in exactly the same spatial relationship. In addition to indicating errors located in the proof copy, the proofreader adds to the data sheet the Listomatic Code for the number of lines in the entry. Errors are noted on the proof copy, which is returned with the tape to the typist for corrections. Corrected copy is returned for reproofreading with all documents except the original defective tape, which is destroyed by the typist. The rate of proofreading is approximately the same as at the Indexing Assistant station.

After proofreading has been completed, the journal is no longer needed, and is forwarded to the Library stacks. Data sheet, tape, and typed copy move on to the Key punch Station.

*Keypunching.* The first step in the preparation of the punched card is the keypunching of blank cards from information contained on the data sheet and the proof copy. Since output typing is more time-consuming than keypunching, it would be undesirable to do the typing first, as the information would have to be duplicated if errors occur subsequently in the punching. For this reason the punching is done first and the output typing second. The procedure for punching was designed to exploit the maximum utilization of the duplicating features of the keypunch. Selection of field, automatic skipping, and automatic duplication requirements of both author and subject cards are met by the Alternate Program Device controlled from the keyboard.

Keypunching of the required number of subject and author cards, including runovers, begins with the preparation of the subject entry cards, performed in the following manner: First, the numeric code for the main heading is punched in columns 1-5; the check digit for the subject heading code goes into Column 6. If there is a subheading, the three-digit code is punched in columns 8-10, and the check digit is punched into Column 11. The two-digit code for the first initial of the senior or sole author is punched in columns 13-14. (This code is used for arranging entries within subject headings.) The card automatically skips to column 52, where the Listomatic code is punched for 2 and 3 line entries. Next, a code designating the indexer of the article is placed in columns 57-58, one in columns 59-60 for the proofreader, and one in columns 61-62 for the keypunch operator. The card will automatically release after punching, and the following card will feed in.

The card for the second subject entry is punched in columns 1-6 and 8-11 for the new main heading and subheading. The remaining portion of the card is automatically duplicated by holding down the duplicate key; a similar procedure would be followed for additional headings. The card design for the subject entries is illustrated in Figure 17; Figure 18 shows the design of the senior or sole author card, which is prepared next with the aid of the Alternate Program Device.

The alphabetical punching of the senior author card (for 60 per cent of the articles this is the only author entry card) occupies columns 1-19; columns 1-17 are reserved for the surname and columns 18-19 for the first two initials. A special punch in the "4" position of column 20 is inserted only for junior author cards (Figure 19); this punch provides the means of automatically filing the cards for names appearing as junior authors behind the cards for the same names when they occur as senior or sole authors. An automatic skip carries the senior author card to column 52 for automatic duplication of the Listomatic Code from the previous subject entry; in the case of junior author cards, all of which have thus far been one line entries, the card is released after the column 20 punch is keyed. About 400 articles may be keypunched by an operator in a single day; with the three 026 keypunches operating at full capacity about 1,200 articles may be handled.

The accuracy of the punching of the subject codes is checked by the Self-Checking Number Device; the author cards may be proofread visually from the information interpreted across the top of the card. After corrections have been made, the cards are ready to receive the appropriate imprinted entry in the Listomatic area at the top of the card.

*Output Imprinting.* Tape, cards, and data sheet go to the next station, which consists of a battery of 8 point "JU" Justowriters fitted with clamp-type card-holding platens. The tape is inserted in the reader, the corresponding card is inserted in the platen and the machine is instructed to begin typing by "reading"







[illegible]

FIG. 20. Preliminary card design—Listomatic imprinting area



from the recorded entry in the punched paper tape into the exact location on the card. Next, the junior author cards are prepared similarly by inserting the matched punched card in the platen and "reading" the cross reference to the senior author from the tape section following the complete citation. The tape is then reinserted for further runs of the complete citation for the senior author and additional subject cards.

At the rate of about 90 words per minute the "JU" types out justified copy. Output imprinting is, however, about 20 per cent slower than the input typing operation as measured by the number of articles processed for unit of time at each station. The daily output per typist at the input station is around 125 articles and at the output imprinting station the rate is around 100 articles per Justowriter. This seemingly odd circumstance is largely the result of the single recording technique employed at the input end as compared with the multiple entries requiring imprinting and handling at the output end. The equation of the two operations on the basis of the total number of characters typed is as follows:

Input typing: 130 characters (average)

Output imprinting: 470 characters (average)

These figures speak for themselves. The seven "JU" Justowriters thus have a peak production capability of about 700 articles per day.

For entries consisting of more than three lines, it is necessary to prepare two punched cards. After the first three lines have been imprinted, a stop code causes the typewriter to halt, the runover card is inserted in the platen, and the imprinting resumes.

To facilitate the imprinting operation and the inspection of the completed cards, horizontal registration lines corresponding to the exact location of the lines of imprinted text and vertical lines denoting the left and right margin limits were printed on the card. This is shown in Figure 20. Great pains were taken to have these lines printed in a suitable non-photographic green ink, but several attempts to get the right shade that would combine visibility and non-reproducibility failed, and the lines were abandoned. Figure 21 shows how the card now used for the *Index Medicus* appears with black ink alignment marks located outside the camera range.

*Inspection and storage.* The punched and imprinted cards are inspected for completeness and accuracy. The data sheets and tapes for the accepted card sets are discarded and the cards are transferred to storage.

#### MACHINE OPERATIONS

*Preliminary sorting.* The next link in the chain is the mechanical sorting and interfiling of the entries. Each day the inspected cards are mechanically separated into author and subject decks, and the latter are further arranged into seven groups according to the first digit of the subject code. The author cards are sorted

further into senior and junior author decks by reading in column 20 where a punch was provided for this purpose. The seven subject and two author decks are augmented each day during the entire monthly collection period by the daily output of completed cards. End-time operations are appreciably reduced by these preliminary steps.

*Sorting.* The description that follows will be more readily understood by referring to Figure 22 illustrating the sequence of work flow. After the flow of cards into the file for the next issue is cut off, the operation is launched with the further sorting of subject cards contained in the seven stored blocks. As soon as the entire block of cards containing a zero in column 1 is completely arranged, it moves on to the collator, while sorting of the remaining six blocks of cards continues.

After completion of the sorting of the subject cards, the author cards are sorted into an alphabetical arrangement (Figure 23). Machine sorting is almost invariably performed from right to left, the first step involving the sorting on columns 19 and 18, where the author's initials are punched.

This is followed by the length of name sort. This technique divides the deck into 13 parts, one for each pocket of the sorter. Beginning at the left hand side of the machine, the first pocket will contain all names of five letters or less. The next pocket will contain only those with 6 letters; the next those with 7, and so on. The last pocket will contain those with 17 or more letters. Standard alphabetizing continues in descending order by starting with those cards containing punches in column 17, i.e., those with names of 17 or more letters. When sorting on column 17 is completed, the cards are placed in back of the next deck, those which are 16 letters long, and the same procedure is followed again for all columns up to and including column 2. Column 1 has been sorted during the block sorting operation.

*Machine Editing.* The purpose of machine editing is to select the various non-entry cards (headings, subheadings, and cross-references) required for the indexed articles included in the issue. The subject entry cards, now sequentially arranged, are matched on the 087 Collator against a similarly arranged deck of non-entry main headings and subheadings. Since there are about 5,000 main headings and 67 subheadings in the system it is theoretically possible to have about 335,000 combinations. Many of these combinations are, however, logically impossible, as, for example "LIVER—related compounds," or tautological, as in the instance, "SARCOMA—neoplasms." Consequently, only the relatively low percentage of combinations (about 5 per cent) that are apt to be required for publication purposes were punched and imprinted in advance. All of the possible combinations have not, therefore, been anticipated, and each month there are a small quantity of entries indexed for the first time in the *Index Medicus* system under a new main heading-subheading combination.

The Collator compares the two groups card by card, matching the entire

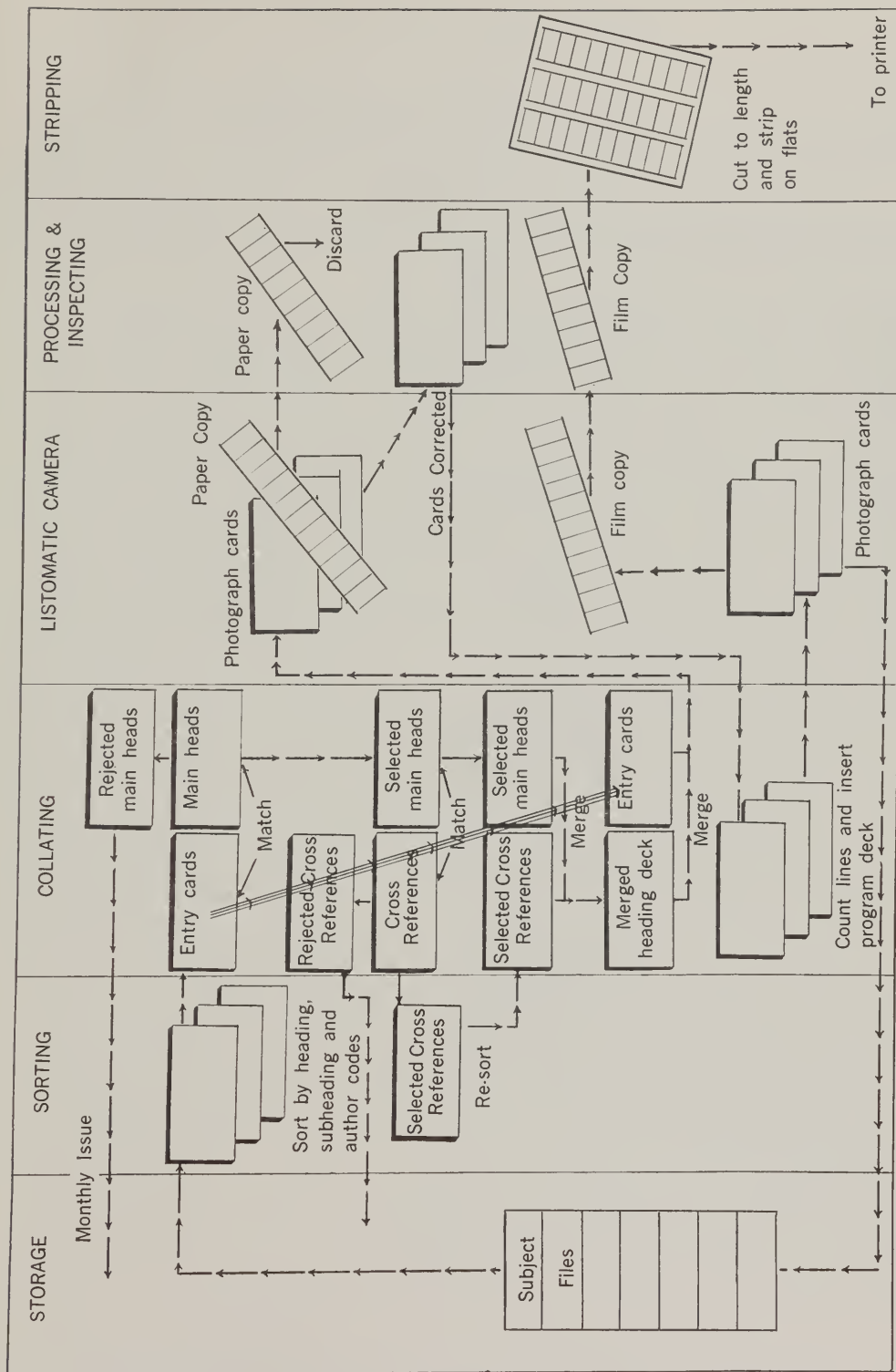


FIG. 22. Machine operation work flow—subject section

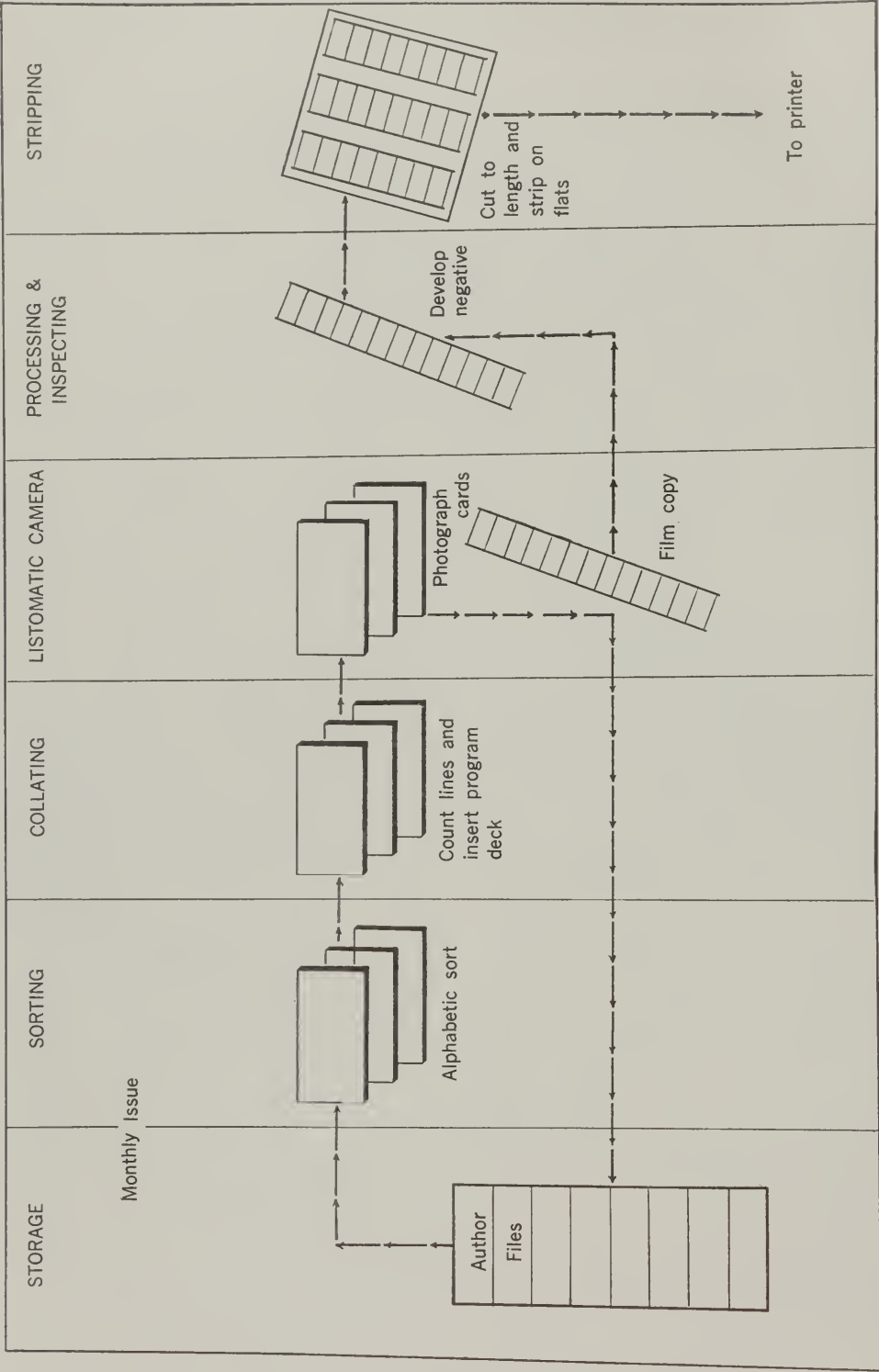


FIG. 23. Machine operation work flow—author section

seven-digit code unit consisting of the main heading and subheading codes. The following four decks of cards are produced by this run:

- 1) A deck of subject entries for which no main heading-subheading combinations were found in the non-entry deck,
- 2) A deck of subject entries which have found their headings,
- 3) The deck of main headings and subheadings belonging to the deck in pocket 2, and

- 4) A deck of headings not called for by the entries in the issue being prepared. Some needed main headings will, however, fall in with the discards in pocket 4, namely, the main headings which lack "up front" entries, or entries under the main heading alone without subheading. These must be sorted out and matched and merged with the deck from pocket 3. For example, in order to print "ABDOMEN, surgery" two cards are required, one for "ABDOMEN" and a separate one for "surgery." Although the "surgery" card is coded for both the mainheading and subheading, the reverse is, of course, not true. If there is no entry under plain ABDOMEN that card will fall in pocket 4 with the discards on the first matching, and must be retrieved and placed at the front of its subheadings. Next, the missing cards indicated by the deck in pocket 1 must be imprinted and punched.

Selection of cross references is accomplished by matching the selected main heading-subheading cards against the "see" and "see also" cards which are arranged alphabetically by the heading referred to, that is, the "see from" or "see also from" order. The "see" and "see also" cross references, selected by the term referred to, are rearranged on the sorter by the term referred *from*, and are then merged (on the collator) with the non-entry deck of headings and subheadings. Finally, the combined headings, subheadings and cross references are merged with the entries to form the publication deck for the Subject Section of the *Index Medicus*.

Of the 14 major steps required to assemble the publication deck each month, half are basic machine operations and the remainder are operations required to provide for error correction or generation of new main heading-subheading combinations. The flow of these functions is illustrated in Figure 22; the time required for each specific operation appears in the schedule shown in Figure 24.

*Filming and processing.* After final assembly, the cards are filmed in the Listomatic camera which is loaded with either positive or negative photographic paper. After processing, the paper copy is reviewed in order to eliminate various types of defects which may have crept into the finished product. Defects picked up during inspection include improper horizontal and vertical registration, incorrect Listomatic codes, duplicate entries, and absence or reversed order of runover cards. Defective cards and conditions are corrected and hand-inserted into the publication deck.

The complete deck is next run through the collator, which contains the Listo-

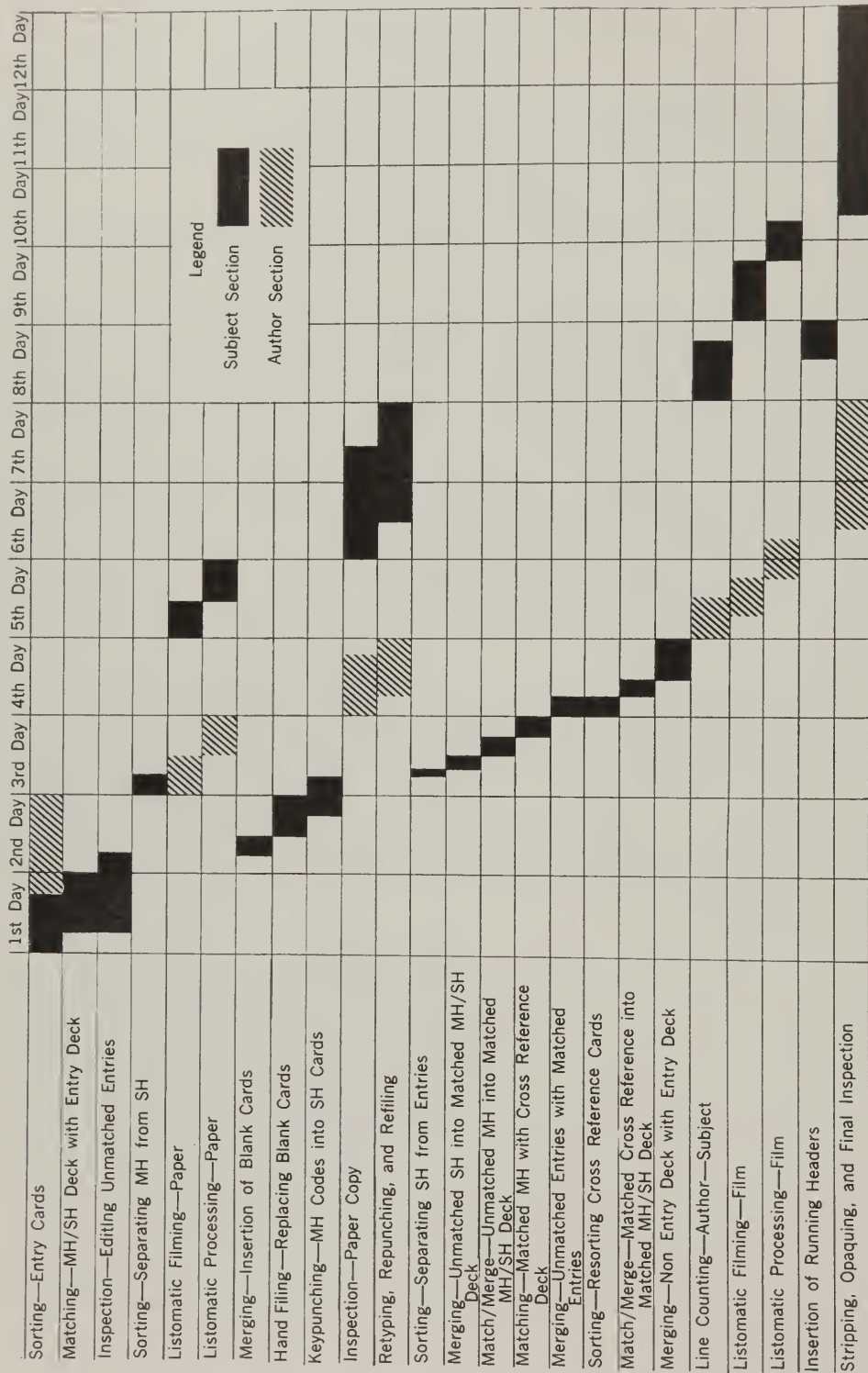


FIG. 24. Schedule of machine operations

matic program deck in the other feed. The Listomatic codes are read with the aid of the Code Accumulate Device and, after each 100 lines, blank space cards are interspersed, which later facilitate the cutting of the processed film into columnar strips. In addition, the program deck consisting of 16 cards for each two pages identifies each column by page and column number, adds the page number that will actually appear on the final printed page, and inserts a colored indicator card to permit hand insertion of running heads at the appropriate places. A specimen Listomatic program card is illustrated in Figure 25.

Running heads are hand inserted at the places indicated by colored program cards. Since the precise running head on any given page cannot be predicted in advance of the page make-up this operation does not lend itself to a mechanical solution.

The complete publication deck including Listomatic program cards is next run through the camera, now loaded with film. To date the film has been sent to New York by overnight bus transportation, processed during the day, and returned to Washington by the same carrier in time for inspection and cutting the following morning.

*Stripping.* The processed film is cut into columnar lengths and inspected for opacities or other technical defects. The film for the three columns which comprise a page are then inserted into individual envelopes. Stripping of the cut columns into page form is currently performed by use of film masks (Figure 26) with clear windows where the strips of film are to be adhered. The mask is placed on the surface of a light table or box, the column strips are carefully centered in the window and adhered top and bottom with red Paklon lithographers' tape. The masks proper are produced by a separate contact printing procedure at an approximate unit cost of 60 cents. The average longevity of a mask is about six trips to the printer, and problems in reclamation as well as cost resulted in efforts to develop a vacuum stripping box which dispensed with the need for masks. Using such a box, film strips are held in proper position by suction from below while the strips of Paklon tape are placed between the contiguous columns. The extremely narrow margins resulting from the use of 2.67 inch film create problems subsequently in the placement of the stripped pages into the sixteen-page goldenrod sheets by the printer prior to plate making. This can be resolved by the printer through the use of die-cut windows in the goldenrod. After stripping, the pages are opaqued to cover imperfections such as scratches and blow holes. After inspection, the pages are assembled and packed with paper sheets interleaved between the stripped film for shipment to the printer.

*Cumulation interfiling.* Each month thousands of cards are assembled to produce an issue of the *Index Medicus*. After they have been passed through the Listomatic camera the same cards are to be exploited for cumulation purposes.

The problem is to choose, from among many alternatives, the optimum schedul-

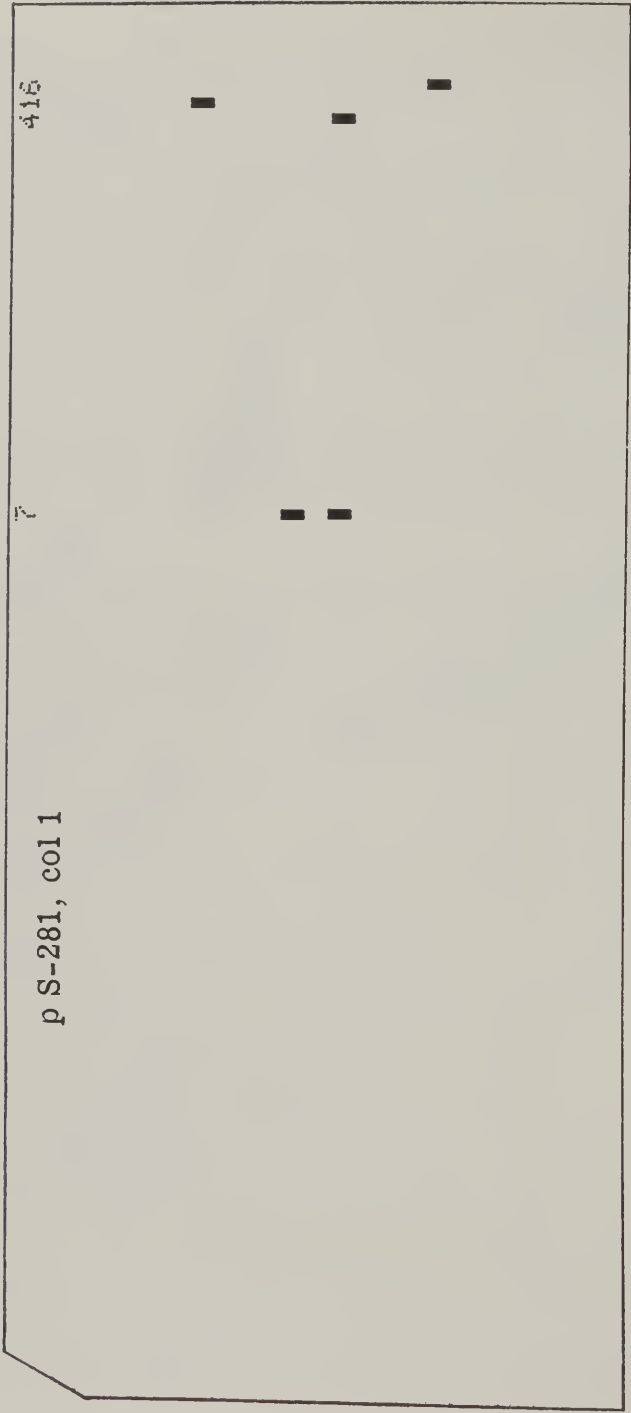
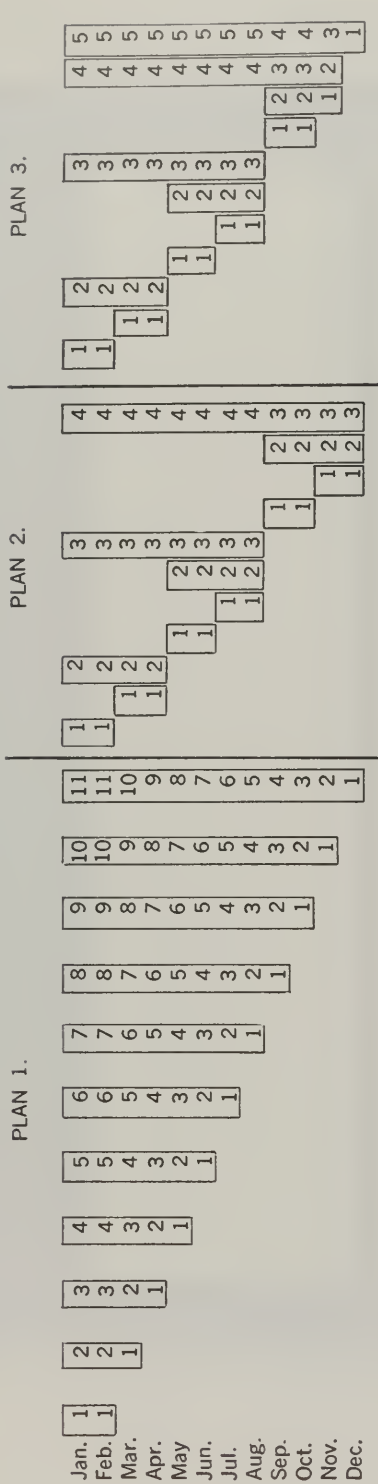


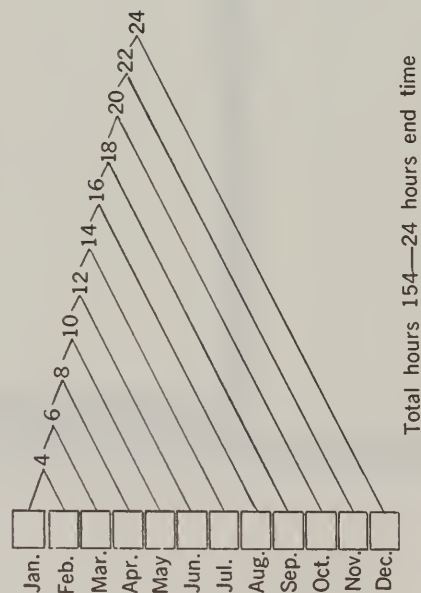
Fig. 25. Listomatic program card



FIG. 26. Stripping mask (film negative)

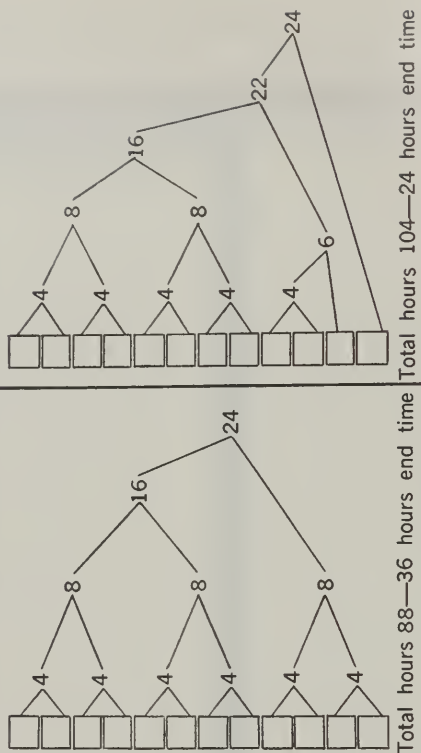


Blocks above denote status of cumulation. Figures give total number of unit card passes at each stage.



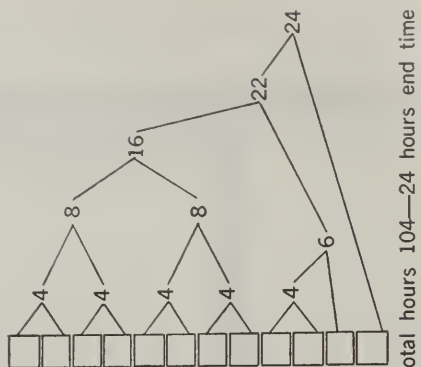
Total hours 154—24 hours end time

1,925,000 Card passes



Total hours 88—36 hours end time

1,100,000 Card passes



total hours 104—24 hours end time

1,400,000 Card passes

Lines show assembly pattern. Figures give number of hours for each assembly operation.

FIG. 27. Alternate plans for cumulation interfiling

ing scheme to adopt for the interfiling of entries for the Cumulation. Two factors are important to consider in this regard: first, the total end-time required from the time the December issue has been put to bed until the Cumulation is ready; and second, the total time consumed throughout the course of the year down to the last issue. Of the many approaches that may be followed, the three that appeared most promising for the *Index Medicus* system are illustrated in Figure 27. Plan 1 is the simplest of the three. Each month the newly completed issue is interfiled with the previously interfiled issues until the twelfth issue is finally merged with the combined eleven issues at the end. From the viewpoint of end-time, the 24 hours required in using this system is as good as any other, but the total time, 154 hours, is rather high.

In Plan 2, the monthly issues are manipulated as pairs. January and February are combined but the March issue, instead of being merged with its predecessors is held until the April issue appears and is then combined with its successor. The two pairs are then combined. The next pair (May-June) is merged with the pair that follows (July-August) and the two pairs form a second quartet; the January-April segment is then merged with the May-August deck. Next the September-October pair is merged and, following the combination of the November and December issues a third quartet is formed (September-December) which is finally interfiled with the rest of the year's entries to complete the process. The chief virtue of this plan lies in the relatively small amount of time (88 hours) it requires throughout the year; end-time, however, is 50 per cent higher than Plan 1.

Plan 3 is identical with Plan 2 up to the November issue, which in this scheme is immediately added to the September-October duo; this segment is then added to the previous eight months' entries and the December issue is finally merged with the January-November entries as in Plan 1. As can readily be seen, Plan 3 combined the best parts of the other two plans and the result is a happy combination of the lowest end-time (24 hours) with a total year-round time of 104 hours, which is less than 20 per cent higher than the low achieved in Plan 2. Plan 3 was, therefore, adopted.

To date this schedule has worked well in practice. The acid test will come in November when the "end-time period" commences. The outlook is bright for the rapid and painless publication of the *Cumulated Index Medicus* despite its huge size, which is certain to run well over 4,000 pages and must appear in several volumes.

# Operational History

THE HISTORICAL and technical background of the project has been furnished, the final system that evolved has been described and analyzed, and now, to add a further dimension to the picture, an attempt will be made to recount some of the actual operational experience. Month-by-month documentation of selected highlights will be presented in logbook form. The appropriate point in time to begin this history is with the genesis of the project, about eight months before its official commencement.

*November 1957.* The preliminary plan for the mechanized publication system was presented to the National Library of Medicine Board of Regents. The Board approved the plan and recommended that the Library seek extramural financial support for a research project.

*December 1957.* The drafting of the proposal to the Council on Library Resources, Inc., was begun. The Chief of the Index Division attended a course in automatic data processing at the International Business Machines school at Endicott, N. Y.

*February 1958.* The application for the grant was submitted to the Council on Library Resources. Several supervisory staff members began training in machine operations at the local IBM Educational Center.

*March 1958.* A detailed request for authorization to procure various items of equipment was submitted to the Congressional Joint Committee on Printing and Binding. The study of step cameras was intensified. Staff training at the IBM school was extended.

*April 1958.* The Council approved the Library's grant application. Plans were made for the preparation of a machine laboratory room to accommodate the equipment to be used in the project's work.

*May 1958.* The Joint Committee on Printing and Binding approved the procurement of the Listomatic Camera and tape-operated typewriters.

*June 1958.* The Secretary of the Department of Health, Education and Welfare formally accepted the grant. The procurement of tabulating equipment was authorized. Soundproofing and air conditioning of the machine room was completed.

*July 1958.* The project was officially in existence. The Listomatic camera was

delivered, but not installed. Orders were placed for the rental of IBM and Remington Rand data-processing equipment.

*August 1958.* The camera was installed and ready for operation. Conferences were held with various consultants. The Assistant Division Chief observed the Listomatic System at Dun and Bradstreet in New York. The experimental list of broad subject categories was compiled for use in the study of the bibliographic retrieval phase of the project.

*September 1958.* The Advisory Committee was set up. Conferences with the consultants continued.

*October 1958.* The first version of a plan for the publication system was evolved and was discussed at the first meeting of the Advisory Committee. The IBM 046 Tape-to-Card Converter and 082 Sorter were delivered.

*November 1958.* Further refinements of the publication system were made, pointing toward decisions about major equipment needs of the project.

*December 1958.* Four Friden Justowriters were ordered for delivery in April or May. An IBM 12 point bold face electric typewriter was equipped with a clamp-type card-holding platen, and preparation of copy for Listomatic production of Volume 4 of the *Bibliography of Medical Reviews* began. The Advisory Committee met for the second time and reviewed the proposed system. Preparation of a revised subject heading list commenced.

*January 1959.* The camera was now in experimental use. The first printing punch was not expected before the middle of March, and the Collator not before summer. One operator was trained in the use of the camera. The Medical Subject Specialist was assigned to work with a representative of the Catalog Division on the Subject Heading Authority List. The first progress report to the Council on Library Resources was being prepared.

*February 1959.* The first progress report was completed and distributed.

*March 1959.* Orders for supplies and equipment were made firm. The Listomatic camera was used in trial runs on material for the Library of Congress and for the Index Division. Work began on a new list of journal title abbreviations. Another operator was trained in the use of the camera. In fulfillment of a requirement of the Bureau of the Budget, a detailed justification for the renewal of the three-year authorization of the new index was prepared. Plans were made for further staff training and for space allocations for the new system.

*April 1959.* Two staff members completed the IBM Machine Operations course, and two took the two-day concentrated course of training on the Friden "AA" Justowriter.

*May 1959.* The Collator, ordered over nine months before, was still undelivered. The Assistant Chief observed the Listomatic operation at the Atomic Energy Commission Technical Information Service in Oak Ridge, Tennessee. Another staff member took the IBM course in Machine Operations. A serious pro-

blem in connection with film processing arose, suggesting that the Morse tank (limited in the length of film processable at one time) would be unsuitable for the project's needs. In spite of difficulties due to lack of a Collator, the fourth volume of the *Bibliography of Medical Reviews* was processed and filmed on the Listomatic camera, as a shakedown run.

*June 1959.* All major items of equipment were by this time on order. The 083 Sorter and the 087 Collator finally arrived. Two more staff members completed the IBM Basic Machine Operations course. Purchase orders for other equipment items were placed. The shift was made from the experimental to the preproduction stage in the publication phase of the Council on Library Resources project. The American Medical Association accepted the proposal for a co-operative program for the publication of the *Cumulated Index Medicus*. The Bureau of the Budget approved the three-year extension of the monthly index publication authority, including an increase of the annual maximum page limit from 5,000 to 7,500 pages. The Congressional Joint Committee on Printing and Binding approved the acquisition of equipment required for full scale production under the new system. The second progress report to the Council was being prepared.

*July 1959.* The sound-absorbing cabinets were received. A conference was held with IBM special consultants on bibliographic retrieval. Much work was done on the new list of abbreviations of journal titles. A system was designed and executed for preparing non-entry tab card decks of headings and subheadings. Preparation of "See" and "See also" reference decks and the Listomatic Program Card deck was scheduled for August. The second 026 key punch was received. The second progress report was completed and distributed.

*August 1959.* The first product of the Listomatic camera, Volume 4 of the *Bibliography of Medical Reviews*, was received from the printer. All Divisional activities were consolidated on the third floor of the NLM building. The relation of the various indexing aids used in preparation of the *Current List* to the new *Index Medicus* was being studied. Four sets of non-entry punched card decks of main headings, subheadings, and cross references were started. Preparation of punched paper tapes for imprinting these decks got under way on the Remington Rand Synchro-Tape machine, whose code patterns had previously been modified to conform with the eight-channel Flexowriter on order. Cutting of tapes for the title and abbreviation sections of the "List of Journals Indexed," as well as the edge punched card file of title abbreviations, commenced on the Model "AA" Justowriters. One hundred copies of the new *Subject Heading Authority List* were multilithed from master sets prepared on the Departmental tabulating machines from the NLM punched card file.

*September 1959.* The input Justowriters were working well, but the tape readers on the output Justowriters were causing some difficulties, which later proved to be due to static in the carbon ribbons. Both Flexowriters and all but three Justo-

writers had been delivered by this time, and all were in operation. Desks and acoustical cabinets were satisfactory. A first batch of 9,000 articles was indexed under the new system. A bottleneck developed at the proofreading station that led to modification of the proofreading task. The new intermediate work station of Indexing Assistant was in smooth operation. Seven operators were at least partially trained on the input typewriters. Four keypunch operators were fully trained, and two others were reasonably competent. Imprinting of cards for journal titles and abbreviations for the "List of Journals Indexed" was well along.

*October 1959.* Input typing was improving in quality and quantity. Two keypunches were proving inadequate for punching needs, and another punch was ordered, for probable delivery in March, 1960. There was some down-time on the keypunches, but the chief problems were showing up in output typing, where most of the machine down-time occurred. October 31 was the cutoff date for the January issue of *Index Medicus*, Vol. 1, No. 1. The target was seven thousand items, with 6,216 finally included. Backlogs developed at proofreading, inspection, and Indexing Assistant stations, and were handled by temporary reassignment of indexers. The output typing backlog rose to 1,220 articles. Preparation of non-entry publication decks took much time. The Listomatic program deck, originally scheduled for August, was now postponed until November.

*November 1959.* The camera commenced a long period of malfunctioning, beginning with line skipping, which was traced to a defective tube in the electronic chassis. Green registration lines on the cards showed up on the film, and there was much experimentation with filter, printing plates, and exposure time to alleviate this. Another keypunch was unquestionably needed; the amount of keypunch down-time was considerable. Smudging of the cards by the Collator was noted. Machine assembly of the January issue of the *Index Medicus* began. Sorting and collating went smoothly, but alignment problems were encountered on subject heading cards, and there were problems with subject heading runover cards. Non-entry cards for the January issue were completed. Productivity remained below original estimates. The backlog at the Indexing Assistant station increased, while that at input typing went down. Proofreading was still a headache. Inspection at the keypunch station was abandoned. Output imprinting was slow, only 6,769 items being produced. The last meeting of the Advisory Committee was held on November 30. On November 13 the new *Index Medicus* system was demonstrated to the NLM Board of Regents.

*December 1959.* An increase in output production was discernible for the first time. Dual operation of output Justowriters was attempted and the result was a limited success. Keypunches continued to show mechanical defects, and repair service was often ineffective, ten hours being lost in one three-day period. The keypunching backlog rose to over 3,200. Corrections and punching of non-entry

decks slowed production. Smudging of imprinted cards remained a problem, and a study of typewriter ribbons was instituted. A major crisis arose around the middle of the month, following a report from the newly designated printer that he could not produce a satisfactory lithographic plate from the Listomatic film. Numerous conferences were held, involving personnel from the Library, the Public Health Service, the Government Printing Office, the Recordak Corporation, and the printing establishment. A successful plate-burning trial conducted at another commercial lithographic firm was an important factor in the resolution of the predicament. The film had gone to the printer on December 11, but the impasse caused the tentative publication date to be advanced to January 18. The cutoff date for material for the February issue was December 12, with 9,985 items. Indexing production rose, but was not yet satisfactory. The Indexing Assistant backlog rose to 4,518. Program decks, programming, and scheduling were taking a lot of attention. Page-stripping proved to be a slow job, with an inordinate amount of final opaquing of film required.

*January 1960.* A catastrophe was discovered on January 5. For an unknown length of time the camera had been operating with no exposure light flashing. The entire subject and author sections had to be rerun. Page stripping was performed on a crash basis by four operators. The January issue was delivered from the printer on January 18. The February issue of 9,985 items went to the printer on the 12th. The cutoff date for the March issue was January 21, with 8,317 items. The Indexing Assistant backlog rose to 6,300; the input typing backlog rose to 4,200; the proofreading backlog rose to 3,455; the keypunching backlog dropped almost 3,000 to 584; the output imprinting backlog rose to 3,208. Input typewriters suffered from minor problems such as blown fuses. Key punching improved. Output Justowriters were proving to be prone to breakdown; there were eight days of down-time here. Adequate film processing in Washington was still unavailable, and film was transported via Trailways Bus delivery service to be processed in New York. A mechanical jig for stripping was investigated. A magnetic display board for production control scheduling was proving invaluable. It was decided to use cards without any horizontal guide-lines in the imprinting area. The fifteen-day schedule looked workable if the filming of the paper copy could be dispensed with. Non-entry decks still required a lot of work. It was suggested that headings might be given a two-line, instead of a three-line, space allowance; but this would require a new deck of headings. Additional decks would also be required for the 1960 cumulation. Subheadings needed further attention and editing.

*February 1960.* The processing of film in New York was working well. Among the month's misfortunes was a preliminary paper copy almost illegible because the filter used to eliminate the persistent horizontal lines had been left on the the camera by mistake. Both collator and camera "chewed up" a fair number of

cards. The down-time for the "AA" Justowriters was more than twice that for January, and the Friden people began the first of their semiannual maintenance inspections. There was less down-time for the keypunches. The February issue was received on February 4. The March issue was shipped to the printer on February 11. The cutoff date for the April issue was February 18, with 10,388 items. Improvement was noted at proofreading and inspection stations. It was decided to prepare runover cards along with regular entries, and no longer as a separate operation. Output typing production rose.

*March 1960.* The strobe light on the camera gave out, interrupting filming for a day. Eight feet of film were found to be underexposed, and had to be rerun and reprocessed. The opaquing process took longer than usual (about a quarter of the masks were new). A switch to fabric ribbon was made on the "AA" Justowriter. A cycle delay kit was delivered and installed on the collator to assist in the elimination of a bare main heading card at the bottom of a column. Six mobile filing units for the input typing work stations were ordered. The new keypunch failed to arrive, but there was only one day of down-time due to mechanical failure. The Friden maintenance check continued. The printer continued to experience trouble. Line counting for paper copy was discontinued. The March issue was delivered late, on March 17. The April issue was shipped to the printer on March 10. The cutoff date for the May issue was March 21, with 10,417 items. About 1,560 new heading and subheading cards took two days to prepare. Approximately 500 out of 56,000 cards line counted for the National Research Council Cardiovascular Project were found to be improperly cut. The input typing backlog was cut from 4,100 to 2,000; this in turn built up the keypunch backlog. A miscalculation resulted in running out of IBM card stock, a rush order brought cards printed with the wrong ink, and consequently blank cards had to be used. Three "JU" Justowriters, an additional desk, and four Friden machine stands were requisitioned. A "buggy top" style of acoustinet was tried, but found unsatisfactory. A sample vacuum stripping box was tried out, and found promising. Output imprinting suffered from the use of the blank card stock and production was slowed, with a considerable amount of retyping necessary. The proofreading backlog went down. Final revision of the subject heading authority list, *Medical Subject Headings*, caused the suspension of virtually all regular work at the Indexing Assistant station for two weeks. The redescription of jobs in the Index Division was started.

*April 1960.* The camera developed a tendency to skip, and much refilming was necessary. The Division staff was 10 per cent below normal. The April issue was delivered on April 1. The May issue was delivered on April 28. The December cumulation of the *Current List of Medical Literature* was delivered on April 5. This was a turbulent month, in which everything went at top speed. The May issue was sent to the printer on April 11, and while the printing was quick, the

quality was below standard. The cutoff date for the June issue was April 23, with 15,892 items. So far all indexing had been done with the preliminary revision of the *Subject Heading Authority List*, and the July issue would be the first based on the new heading list. IBM processing began about a week behind schedule. The film run of *Medical Subject Headings* was marked by camera failure and faulty registration. Of 356 pages, 150 had to be refilmed and reprocessed, and the refilmed portion proved again defective. The input typing backlog jumped to 3,000. Machine down-time was three man-days on the "AA" Justowriters, due partly to the maintenance check and partly to malfunction. The third keypunch arrived on a day when the other two were down. A portable punch was ordered for use at the inspection station to handle omitted punches. Output imprinting was 12,776 articles, but there was trouble with loosening of platen screws. The Listomatic program deck for the June issue took four man-days to prepare. The backlog at the Indexing Assistant station went down to 2,200. Proofreading was proceeding satisfactorily, but the need for full-time proofreaders was clear.

*May 1960.* Technical problems intensified during this month. The camera was still skipping, and as a result an extra thousand feet of film were used. There was a wide variation in background density of the film. A reconditioned electronic chassis was installed and certified operational. The camera then developed a new defect: after opening for three-line entries, the aperture stayed open for one- and two-line entries. Work on job descriptions for the Index Division staff continued. The first cumulation interfiling got under way. The huge June issue went to the printer on May 16, only four days late. The cutoff date for the July issue was May 23rd, with 10,572 items. "AA" Justowriter down-time was nearly five man-days, due mainly to broken justification seekers. The input backlog, nevertheless, went down below 1,000. The new stands at the input imprinting station brought an improvement, both in appearance and in the efficient flow of work. Key punching was still troublesome; all three machines had had symptoms which refused to show up when the repairman was present. The punching backlog rose to more than 4,000. Tab card files were checked and proved to be in need of overhauling. There were heavy receipts of journals, and the indexing backlog rose. Additional typewriter ribbons were tested. A microcard reader was borrowed for experimental study of the registration problem. A new tab card was designed with all lines removed from the Listomatic imprinting area; darker ink could be used to print the form card. Three NLM staff members, one from the Index Division, took a Univac programming course.

*June 1960.* The camera remained a problem. Vacation schedules slowed film processing. Block sorting of the subject section was introduced. "AA" Justowriter down-time was merely one and a half days, for only three machines required repairs. The keypunch situation was improving, although one machine was down seven days for lack of a part. The June issue was received on June 20.

The July issue went to the printer on June 10. The cutoff date for the August issue was June 16, with 10,280 items. The publication of *Medical Subject Headings* was delayed until August. The "JU" Justowriter output backlog was reduced; the additional machines were scheduled for delivery in August; down-time here was five man-days. Two staff members attended a two-week Institute on Information Storage and Retrieval. Listomatic camera service was again offered to the Library of Congress for publication of the revised edition of *Symbols Used in the National Union Catalog of the Library of Congress*. Two complete decks of main headings were begun, one to be used for cumulation and the other for monthly issues beginning in January, 1961. Inspection efficiency was increasing. There were many special projects under way and more under consideration.

## Cost

THE QUESTIONS asked most frequently about the entire system are those pertaining to the costs of operation. These are fundamental questions that are deserving of the most candid answers possible; the answers are not, however, a simple matter. One of the chief difficulties stems from the fact that appropriated funds are not made available on the basis of an individual publication or a specific program; instead, administrative practice dictates that the allocation of money be made to organizational units which generally have under their wings more than a single activity. Consequently, the attempt to determine the portion of the total budget of the unit which goes toward the support of a specific program is beset by all kinds of difficulties, some of which can be resolved only arbitrarily or partially. This does not preclude the successful compilation of meaningful fiscal data. Its deeper meaning is that in order to accomplish this, more than superficial thought must be put into the organization of material to be used; available data must be carefully studied for possible additions or subtractions which may be valid and which may have a significant effect on the conclusions which are drawn.

Another major inherent complication is the fact that the material presented will, of necessity, be based on the first year's operation of a totally new system, and an incomplete year at that. The first year of a new venture is routinely atypical because of the need to expend efforts devoted solely to the inauguration of procedures. After the initial shakedown period these investments of time and money continue to pay off, without further expenditure of appreciable magnitude. In this category is, for example, the training and orientation of personnel operating the new equipment; another example is the preparation of decks of non-entry punched and imprinted tabulating cards which are re-used many times after their initial production. These factors contribute markedly to increasing the cost of the first year's operations. The result is to distort the fiscal picture, as compared with subsequent years' expenditures or with retrospective figures relating to the experience in a well established operation such as the *Current List*, eight or nine years after its inception. To this can also be added the indeterminable but demonstrable expenditure of effort attributable to normal trial and error in a new operation. Shifting personnel, changing procedures, modifying forms all take a monetary toll of considerable magnitude and make difficult a reasonable and objective analysis of net cost.

Finally, the change of format and frequency of issue, together with the arrangement with the American Medical Association which provides for the financial support of the printing of the *Cumulated Index Medicus*, create further difficulties. The *Current List* consisted of ten regular monthly issues and two semiannual cumulations; the *Index Medicus* itself, on the other hand, comprises twelve monthly issues but no cumulation. This difference makes it difficult to equate the two programs in terms of the cost of the services rendered to the user. To complicate matters further, although the NLM does not pay for the actual printing of the *Cumulated Index Medicus*, it does make a substantial contribution to the publication in the form of the equipment and personnel used to interfile and photograph the cards, the photographic film and paper, and the cost of its processing. In total, this sum may be comparable to the sum expended on the printing and binding of the old cumulations.

With these shortcomings recognized, it is possible to approach the cost appraisal of the system with a clearer perspective and a firmer understanding of the data.

One of the objectives sought by the project from the beginning was the reduction of the unit cost per article indexed. It was clear from the outset that an absolute reduction in the total expenditure, regardless of the number of items processed, would not be likely to be demonstrable due to the proportionally huge capital outlay for equipment which was necessary. It appeared reasonable, however, to expect that the increased number of units processed would ultimately offset this outlay to a degree that would materially contribute to the overall justification of the entire system. How soon this would materialize and how great the gain would prove to be were difficult to predict.

A summary of the cost incurred under the two systems appears in Figure 28. The year 1958, rather than 1959, was chosen as a basis for comparison because it gave a more accurate picture. By 1959, the new *Index Medicus* research project had already become so entwined with *Current List* in operational aspects that the expenditures to be charged to each had become hopelessly entangled.

From these figures it can be seen that, despite a rise in the absolute cost of the *Index Medicus* operation of \$41,540, the unit cost per article has remained virtually unaltered. The first steps have thus been taken toward the attainment of one

	Current List (1958)	Index Medicus (1960)
Items indexed.....	106,513	125,000*
Total budget.....	\$232,385	\$273,925
Unit cost per article indexed.....	\$2.18	\$2.19

\* Estimated. For the ten months, January through October, 1960, a total of 103,866 indexed articles have been printed. This averages 10,386 items per month, or 124,632 for the 12 issues of the calendar year.

FIG. 28. Summary of costs

	Current List (1958)	Index Medicus (1960)	Net Increase
Personnel .....	\$200,000	\$200,000	—
Equipment .....	2,375	11,750	\$9,375
Supplies .....	3,660	8,875	5,215
Printing .....	17,800*	32,000	14,200
Contractual services .....	1,450	5,700	4,250
Rentals .....	—	8,500	8,500
Distribution cost .....	6,100	6,100	—
Miscellaneous .....	1,000	1,000	—
Total .....	\$232,385	\$273,925	\$41,540

\* Does not include cost of printing semiannual cumulations.

FIG. 29. Detailed comparison of costs

of the major objectives of the new system, the expansion of coverage, with an approximate 17 per cent increase in the number of articles indexed and published. Although our experience during the first year did not bring about a lower unit cost, there is every reason to expect that further increases in coverage in the coming years will be accompanied by significant savings. Offsetting this picture, however, is the fact that the summary includes hidden economies that have resulted not from the intrinsic virtues of the mechanized aspects of the system but from changes in form of entry and the like.

A more detailed breakdown of the costs is given in Figure 29.

*Personnel.* The figure \$200,000, which is given for personnel, is accurate for both operations. There is however, a possibility that in the future a real saving in personnel may develop. Thirty-eight people took part in the preparation of the *Current List*, and the same number participate in the new operation. Despite the need for new and special types and quantities of skills, the same individuals, due to the lag and rigidity which have hindered reorganization, have been employed. One result has been some inefficient use of professional staff for subprofessional duties; the cost implications of this practice are obvious.

Since the introduction of the new system, the ratio of professional to clerical employees has shifted. Whereas in the *Current List* system the total task was about equally divided between the two categories, in the new system a proper ratio is:

Professional staff .....	11
Clerical-subprofessional .....	21
Supervisory-administrative .....	6
	<hr/>
	38

The 2:1 ratio of clerical-subprofessionals to professionals is due largely to the change in indexing format, not to any magic in the system itself. In the Subject Index of the old *Current List* subject analysis was made on three levels: the main heading, the topical subheading, and the "modification," or capsule abstract. The elimination of the modification in the *Index Medicus* format has resulted in a substantial economy of time, which in turn has reduced the number of in-

dexers required. The eventual transition should lower the personnel budget, although the total staff will remain the same size.

Two other trends in personnel are discernible. Mechanization has created a need for a new class of employees to handle a function nonexistent in the preparation of the *Current List*. Indexing assistants, subprofessionals in the main, now convert the work of the professional indexers to machine-readable language (numerical codes) prior to the further processing of material in the system. Another consequence of the mechanization has been the increase in administrative-supervisory personnel needed to control the flow of work. These two trends will probably offset to some degree the decrease in the number of indexers.

*Equipment.* The figures given in Figure 29 are derived by amortizing the total capitalization of the equipment on an eight-year basis. The \$94,000 capitalization for the new system consists mainly of the Listomatic Camera (\$20,000) and the battery of 15 Justowriters and Flexowriters (about \$50,000); the remainder of the total, about \$24,000, consists of smaller items such as sound absorbing cabinets for the typewriters and keypunch machines (about \$4,000), light tables for stripping, tabulating card cabinets, and other storage and transport equipment. It should be noted that all cost quotations in this report are based on price schedules available only to agencies of the Federal Government; in general these prices are probably lower than those on the open market.

It should be remembered that *necessary* equipment for the basic Listomatic system consists solely of the camera, a keypunch, and typewriter or other composition machines equipped to hold and imprint tabulating cards. In the case of the *Index Medicus*, if other refinements had not been incorporated into the system the total capitalization for a basic system could conceivably have been around half the amount actually expended. Standard electric typewriters equipped with card holding platens cost less than \$1,000 apiece, instead of the \$3,000 to \$3,600 for the tape machines; dispensing with the acoustic cabinets effects another considerable saving; and so on down the line..

Because of the inability to handle the composition of *Index Medicus* more effectively, the original estimate for equipment has been exceeded. Almost twice the number of composition machines which were expected to be adequate are now on the premises. The fact is that the 15 composition machines used to prepare copy for the *Index Medicus* represent about one and a half times the number of electric typewriters used for the same purpose in the *Current List* operation, which contained no duplicative features of any kind. But again, this results from differences in format and in the number of articles covered. The number of characters per indexed item printed in the *Index Medicus* is 44 per cent more (average 472 compared to average 263) than the number printed in the old *Current List*.

*Supplies.* Photographic paper and film are the largest single items accounting for the increase in supply expenditures. Each issue of the *Index Medicus* requires about three rolls of film which cost \$45.00 each, and an equal number of photographic paper rolls which cost around \$20.00 per roll. Any camera or processing

malfunction which requires refilming will contribute a corresponding increment to the supply outlay. The normal monthly cost for photographic supplies is therefore around \$200, or \$2,400 per year; a similar amount is included in the budget for the running of the *Cumulated Index Medicus*. Thus, more than half of the supply budget of the *Index Medicus* is directly related to this one item.

Other supply items that round out the total expenditure are tabulating cards, a relatively inexpensive item at a little over a dollar per thousand, totalling about \$1000; Justowriter and Flexowriter paper tapes which cost about a dollar per roll; paper typewriter ribbons, and miscellaneous articles.

*Printing.* The printing costs for the *Current List*, as shown, include only the ten regular issues in which new material appeared; they do not include material for the two cumulations. This is not entirely fair, for some cumulation costs are included in the *Index Medicus* figure. As given, the figures make the most stringent comparison between the two systems.

For the regular issues, the *Current List* consisted of only about 77 per cent of the number of pages that are now required for the *Index Medicus*. But the number of articles covered in the old *Current List*, in the year being compared, was only about 80 per cent of the number being covered in the *Index Medicus*. This means that, not considering cumulations in either case, the number of pages required for an equal number of articles is about the same in both cases. This would seem to be a paradox. The explanation is to be found in the amount of page area expended in the *Current List* on printed text (such as the journal titles and place of publication which were given in large bold type in the Register of Articles Section) which is not needed in *Index Medicus*, and blank space. This finding indicates that the *Index Medicus* format is capable of a more efficient utilization of available page area than the *Current List*. The real difference in number of pages required comes in the cumulations. Under the *Current List* system, the cumulated indexes required about an additional 50 per cent of the number of pages required for the individual issues; under the *Index Medicus* system, the requirement of pages for cumulation is perhaps only 90 per cent of the requirement for individual issues.

During the ten years that the monthly *Current List* was published the per page printing cost fluctuated widely over a range from about \$4.75 to \$7.25 per page; in 1958, the NLM paid about \$5.60 per page for this publication.

Manuscript for the *Current List* was submitted to the printer in the form of shingled typed slips of paper adhering to a pasteboard backing; these pages were photographed and lithographic plates were burned from the negative thus produced. In the Listomatic system, the printer's copy is submitted in a more advanced state; the manuscript is now already a photographic negative stripped into page format ready for plate-making. It was therefore reasonable to anticipate that the per page cost of printing would be lower under the new system than under the old method. The lowest bid for the first *Index Medicus* contract, however,

proved to be around \$6.80 per page, an increase of 20 per cent over the *Current List* price. Inflationary trends may have been a minor factor, but certainly not sufficient to account for the result. The fact that no local printer had any previous experience with Listomatic manuscript material was perhaps the major factor that led to the higher cost.

It must be pointed out here that the printing costs given for both systems, cover only the first 1,800 copies of the print run, which NLM receives for its own distribution. The Federal government fiscal arrangement for printing provides for the payment by the originating agency (NLM) of the costly initial set-up charges for the entire run, as well as for the actual paper, presswork, and binding, for its own copies. The more than 4,000 additional copies distributed by the Superintendent of Documents at the Government Printing Office are not included in the cost figures which appear in the tables; the unit cost of these copies will regularly be considerably cheaper than the price paid by NLM for its portion of the total run.

*Contractual Services.* Under contractual services have been gathered several kinds of services which are financed by contract arrangements, generally with nongovernmental organizations. The two major items in this category are photographic processing and composition machine maintenance.

The cost of processing photographic film on paper is approximately the same, about \$.05 per running foot regardless of its width or about \$20.00 for a 400 foot roll. The total cost for the 12 issues of the *Index Medicus* (including preliminary paper trial runs and re-runs of defective material) is, therefore, around \$1,500; a similar amount should handle the processing of paper and film for the *Cumulated Index Medicus*.

The annual maintenance cost for each Justewriter or Flexewriter is approximately \$175, or about \$2,625 per year for the fifteen machines in use. This is a high price to pay for this service, but dispensing with contractual maintenance and depending on pay-as-you-go service-call maintenance is not satisfactory either financially or operationally. Considering how prone these capricious machines are to breakdown it would be unwise to forego the luxury of the service contract.

*Rentals.* This class refers exclusively to the rental of punched card machines. Since there were no punched cards used in the old system, the total amount of this item (\$8,500 per year) now is new to the budget. The monthly rental charges for the IBM machines and auxiliary devices used in the preparation and manipulation of cards for the *Index Medicus* are as follows:

083 Sorter—Basic charge.....	\$110	
Multiple column selector.....	45	
Alphabetical sorting device.....	15	
	<hr/>	
Total.....	\$170.00	\$170

087 Collator—Basic charge.....	\$245	
Code accumulating device.....	25	
Cycle delay kit.....	2	
	<hr/>	
Total.....	\$272	\$272
026 Printing punch—Basic charge.....	\$60	
Alternate program device.....	3	
Self checking number device.....	25	
	<hr/>	
Total, each.....	\$88	
Total for three punches.....		\$264
Total monthly rental.....		\$706
Total annual rental.....		\$8,472.00

Figure 30 shows a detailed analysis of the costs of each individual operation of the *Index Medicus* system.

Put another way, the breakdown of expenses might be set out as follows:

Administration.....	10%
Indexing (including code conversion).....	32%
Composition (typing, inspection, proofreading).....	32%
Machine manipulation (keypunching, sorting and collating, filming and stripping).....	13%
Printing and distribution.....	13%
	<hr/>
	100%

This has an interesting implication. Let us break the composition segment into two equal halves, to represent the input and the output typing. Now, presumably, any system would have to include as a minimum all segments here listed except output typing and machine manipulation. This means that for the total operation only about one-third of the costs are actually susceptible to significant change brought about by the particular machine manipulation system (*e.g.*, computers) which might be used.

*Conclusion.* Most of the data presented in this chapter should be considered as tentative and incomplete, mainly because of their derivation from a portion of an atypical first year's experience with the new system. Viewing the system for the moment solely from the standpoint of its cost, the conclusion is that the project has achieved initial success in the attainment of objectives. It may be predicted that unit costs will decrease as the number of articles covered is further increased. It would be a grave error, however, to measure the project primarily from the cost viewpoint; in the next chapter other successes and failures of the new system will be appraised.

	Indexing	Indexing Assisting	Compo- sition	Proof- reading	Key- punching	Machine operation	Filming and stripping	Adminis- tration	Printing and distrib- ution	Miscel- laneous	Totals
Personnel	71,000	12,000	53,000	21,000	7,000	8,000	2,000	26,000	....	....	200,000
(Number of positions)	(11)	(2.5)	(13)	(4.5)	(1.75)	(1.75)	(0.5)	(3)	....	....	(38)
Equipment	275	75	8,025	75	75	200	2,625	400	....	....	11,750
Supplies	300	50	2,500	....	300	300	5,000	425	....	....	8,875
Rentals	....	....	....	....	3,200	5,300	....	....	....	....	8,500
Contractual services	50	25	2,625	....	....	....	3,000	....	....	....	5,700
Printing and distribution	....	....	....	....	....	....	....	....	38,100	....	38,100
Miscellaneous	....	....	....	....	....	....	....	....	....	1,000	1,000
Totals	71,625	12,150	66,150	21,075	10,575	13,800	12,625	26,825	38,100	1,000	273,925
Unit cost per article (125,000 articles)	.57	.10	.53	.17	.08	.11	.10	.21	.30	.01	2.19
% of total budget	26.0	4.6	24.2	7.7	3.7	5.0	4.6	9.6	13.7	0.5	99.6

Fig. 30. Costs of individual operation

## General Appraisal

THE PRINCIPAL AIM of the project was to devise a system that would permit publication of an index of greater coverage, currency, and ease of preparation and use than had been possible with the old *Current List* setup. It was hoped that in attaining these ends lower costs might also be achieved. It is yet too soon to draw definite conclusions, but some tentative judgments have emerged.

The 1958 quantitative study of the medical periodical literature\* was conducted to furnish a starting point for further examination of coverage. From this inquiry it was possible to estimate for the first time the portion of the literature covered by the *Current List* and the portion not included. The knowledge that only half of the available material was being encompassed spurred the Library to renewed efforts to broaden the coverage of its index. But because of inherent impediments in the *Current List* system a dead end had been reached; expansion much in excess of 110,000 articles per year was not feasible.

From its favorable vantage point the Library could assess the residue of unindexed material, and could conclude that it might not be necessary or desirable to cover more than perhaps half of it. Since the survey\* indicated the existence of about 220,000 items per year, the target level for the new *Index Medicus* would, therefore, be in the neighborhood of 165,000 articles. It was decided to aim at 180,000 articles, to be attained by stages over a five-year period. The five-year plan was made along the following lines:

Volume 1	(1960)	120,000 items indexed
Volume 2	(1961)	135,000 items indexed
Volume 3	(1962)	150,000 items indexed
Volume 4	(1963)	165,000 items indexed
Volume 5	(1964)	180,000 items indexed

The ability of the new system to permit this kind of growth without strain was an important question. Ten monthly issues of the new *Index Medicus* have now been assembled containing references to 103,866 articles, or an average of 10,400 articles per monthly issue. At this rate 125,000 articles will be covered in

---

\* BRODMAN, ESTELLE, AND TAINE, SEYMOUR I. *Current Medical Literature: A Quantitative Survey of Articles and Journals*. Proceedings of the International Conference on Scientific Information (Washington, 1958) v. 1, p. 435-447.

1960. This work load has been handled with minimal difficulty and the outlook for the succeeding stages of the expansion program appears to be bright.

As a result of the first year's output, the *Index Medicus*, selling at an annual subscription rate of \$20.00, is furnishing bibliographic information to its subscribers at a cost of less than \$.0002 per article indexed. The way is now cleared for adding coverage of the sizeable Japanese literature and for extending present coverage of material from the Soviet Union. Eventually, it is reasonable to hope that all the "worthwhile" medical literature of the world will find its way into the *Index Medicus*, already the largest indexing service in any subject field.

#### CURRENCY

By currency is meant the relative recency of the material included in a given issue. Does the June issue of the *Index Medicus* contain a preponderance of the March issues of American journals or is it mostly the April numbers? Is most of the European material in the same issue dated February or January? The number of inquiries that have been received have made it evident that this aspect is second in popularity only to the interest in cost. These questions generally take many forms, which are all basically variations on the same main theme: How long does it take under the new system to process a journal from the time it arrives in the Library until the reader holds in his hands the issue of the *Index Medicus* containing the references to the articles that appeared in that particular journal? An auxiliary question concerns the rapidity with which the annual cumulation can be published.

The record of the *Current List* was generally commendable, as has been seen, but there was room for improvement. Two aspects of the old system were particularly undesirable: first, the backing-up of material every half-year during the period when the cumulations were being compiled; and second, the delay in the assembly of the monthly issues due to the requirement of numbering each article and all of its entries in sequential order. The mechanization project aimed to eliminate these shortcomings by designing a new system which would sustain an optimum level of currency.

There are several approaches possible to answer the questions previously posed. In the *Current List*, the Register Section, with its clumping of a known number of articles under the bibliographic reference line including date of issue, offered a convenient method of ascertaining the currency of the material in any given issue. With the new format this technique is no longer available, and other methods will be sought.

A schedule for a typical monthly issue, based on almost a year's actual experience and combined with sober estimates of future trends, is shown in Figure 31. According to this chart the maximum length of time from the receipt of a journal

until the information about the articles in it is in the hands of the subscriber is about 63 work days or 13 weeks; the minimum is about 9 weeks. This includes all operations from start to finish, some of which are more amenable to further condensation than others.

The first line shows the length of time (roughly a month) required for collection of the approximately 10,000 to 11,000 articles in an average-sized monthly issue. Subsequent lines show the history of these articles from that point on until they appear in print and are received by the subscribers. With no backlog present at the indexing station, material is indexed within 24 hours of receipt. The portion requiring revision is processed in the following half day, and on the third day it is ready for coding by the indexing assistants. Each day the preceding day's receipts are processed, and the input typing commences on the following day (Day 4); a half-day later proofreading of this material is underway and the necessary corrections are made within the succeeding four hour period. Meanwhile, keypunching of the material not requiring corrections is begun, and the corrected material follows. About two days later the punched cards for these journal articles are imprinted, and by the ninth day the first batch of inspected cards is placed in storage for the next monthly issue. For the next four weeks, the file of cards continues to grow as the daily increments are added.

Around the thirtieth day after the oldest items for the issue arrived in the Library (about nine days since the last article indexed in the issue was received), the machine operations preparatory to the Listomatic filming are begun. The twelve days required for mechanical arranging, filming, photographic processing, and page assembly bring the issue to the forty-third day. As has been noted in the chapter on the actual scheduling of operations, this interval appears to be susceptible to further compression.

Printing at present requires three weeks or about fifteen work days; however, contract specifications may be written and met which allow no more than two weeks for this function. The final six days shown are consumed in preparation for mailing and in average distribution time required to reach an American subscriber. In all, since the cutoff of new material added to the file of cards for the issue, about six weeks have elapsed. The issue being perused by the subscriber contains material of an average age of about ten weeks since its arrival in the Library.

An important fact about the currency of printed indexes generally is brought out by the chart. Although the time required for some of the operations may be shortened still further by continued managerial inventiveness, there are fairly well fixed time intervals which stand as an immutable base line. It must be indicated that the project is, in fact, merely on the threshold of a schedule such as that presented here. The actual attainment of this operational level does not seem unreasonable; when realized, it will result in a currency performance that measures up well to the objectives sought.

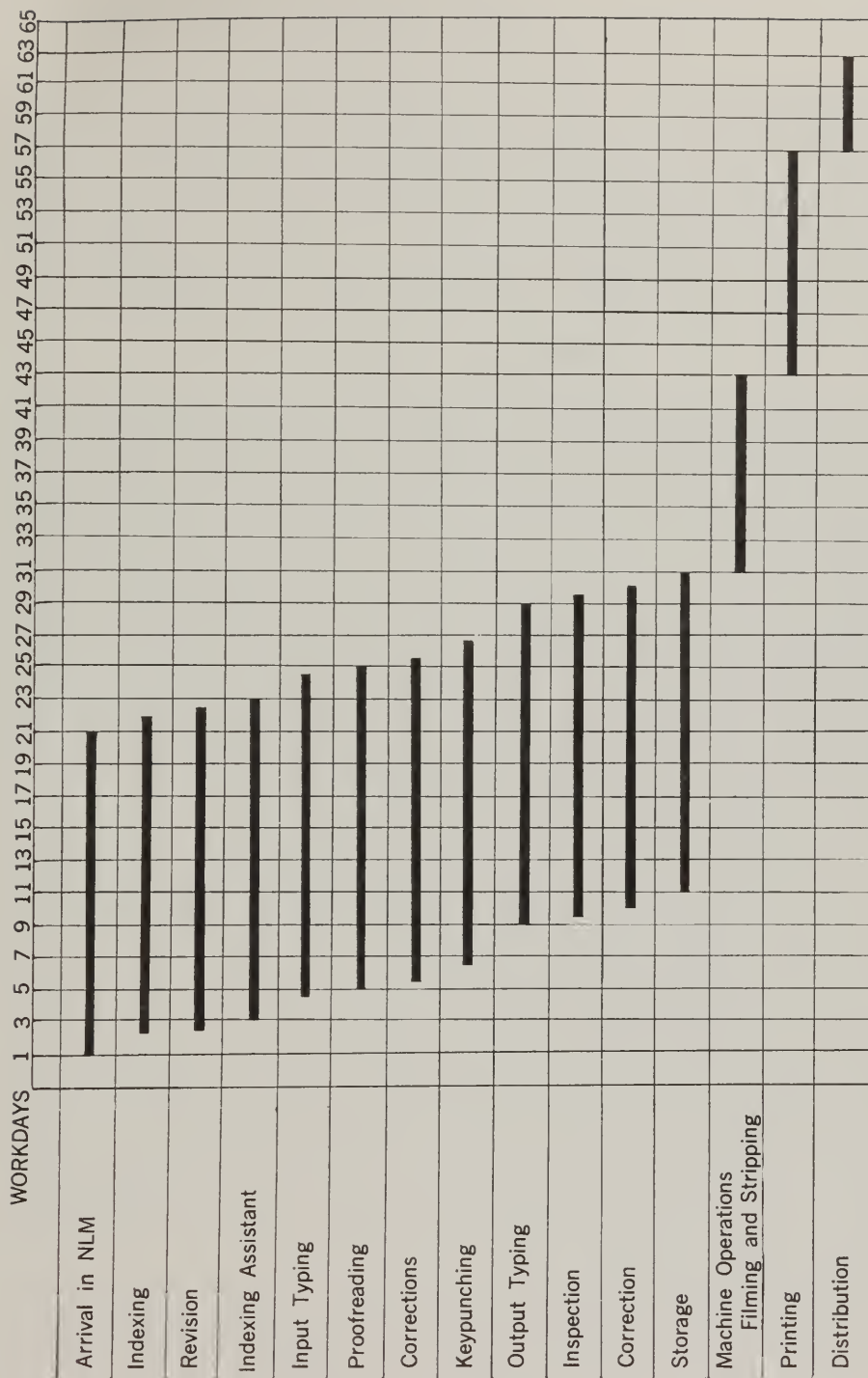


FIG. 31. Time required for processing typical monthly issue

Though not precisely a matter of currency, the rapidity with which the annual cumulation is published is clearly related. There is reason to believe that the execution of this huge task will be achieved in an exemplary manner. By the middle of January (perhaps sooner) the processed film manuscript for more than 4,200 three-column pages will go to the American Medical Association for printing, binding, and distribution. By March, the multivolume *Cumulated Index Medicus* may actually be in use in libraries throughout the world.

#### MANAGEMENT ASPECTS

It is probably fair to say that from the outset of the project there was little doubt about the ultimate eradication of most of the major managerial impediments that were present in the older system. The major pitfall to avoid was the spawning of new substitute problems. For example, once the door was opened on mechanization, there was no reason why the new sorting and collating machines should not resolve the enormous filing problem; unknown, however, was the cost of the input effort of keypunching the cards in order to be able later to sort and interfile them mechanically. Likewise, it was obvious that by using a recording technique for the composition of the unit entry, proofreading would be simplified, but at an indeterminate price. The elimination of the regular twenty-four hour around-the-clock schedule, without which the *Current List* could not have been brought out, was a major objective and all but a foregone conclusion. The new system is clearly superior to the old, but it will be necessary to judge the *Index Medicus* system on its own merits.

*Machine breakdown.* The spectre of machine breakdown haunted the project's investigators long before the first piece of equipment made its appearance in the Library. Figure 32 shows the results of experience with composition and tabulating card machines during the first half of 1960.

It is doubtful if the machine system exists which is not subject to a considerable number of mechanical failures totalling a substantial portion of the available time. This has to be accepted. Just as an employee has a level of dependability which varies within certain tolerable limits, the machines have their own ranges of acceptable performance. After sufficient experience has been gained, it will probably be possible to express this level of tolerance arithmetically, but at present it is possible only to offer the opinion that the record of machine durability that appears in Figure 32 is of an acceptable order and has not placed undue strain on the system.

This comment may be of interest. The more versatile the machine becomes by dint of the addition of various auxiliary devices the greater does its propensity become for malfunctioning. For example, the Self Checking Number Device on the Key punch and the Code Accumulating Device on the Collator have their own special proclivities for breaking down; when this occurs, the entire machine

*Machine Breakdown (Jan-June 1960)*

Type of Machine	Number of Machines	Total Down-time <i>hours</i>	Average down-time per machine per month <i>hours</i>
Collator	1	9	1.5
Sorter	1	2	0.3
Keypunch	2.3	199	14.4
"AA" Justowriters	6	126	3.5
"JU" Justowriters	7	302	7.2

FIG. 32. Machine breakdown statistics

is of little use for operations which require the total mechanism. One further footnote should be added to the auxiliary gadget picture: repair is particularly complicated by the fact that few service men are trained to handle these infrequently used special devices.

*Personnel.* Since the project was inaugurated with a staff composed entirely of tyros insofar as machine operations were concerned, the question of training personnel was cause for considerable anxiety. Typists accustomed to operating standard electric typewriters had to learn how to handle the new features of punched paper tape typewriters; operators had to be trained to keypunch cards and to manipulate the cards in and out of the sorter and collator; a minimum of two operators had to be trained to operate the Listomatic Camera proper. Many other organizations have coped successfully with the first two aspects, and NLM experience was probably little different; it is a conversion that can be accomplished surprisingly quickly and painlessly. The operation of the Listomatic Camera, though more difficult to learn, is not an insuperable assignment for an intelligent individual possessing reasonable machine aptitude and manual dexterity. Training will take some time (perhaps a month or more), but after experience is gained in setting up and running several jobs the Listomatic operator is fully competent. By anticipating needs in advance and by providing a sufficient number of operators for each procedure to keep the work flowing, the problem of personnel training was overcome without much difficulty. The conversion of personnel from the *Current List* system to the mechanized *Index Medicus* system was effected quite smoothly.

*Composition.* The method of imprinting the punched cards is one of the weaker parts of the entire system. At this point in the operation where automation techniques would be most welcome, too much reliance must, instead, be placed on repetitive manual manipulations. The ideal solution would be to key in the information for the complete entry just once, thereby creating a punched paper tape which could subsequently generate all of the necessary punched and imprinted cards for each journal article without any further human intervention. This is not beyond the realm of reasonable expectation today; however, it requires

developing special machines for this purpose, and was not feasible in this project. A composite of selected features which are already possessed by existing pieces of equipment offers great opportunities for full automation.

The recording technique which was adopted is basically sound, but its value is weakened by the cumbersome and time-consuming multiple insertions and removals of tapes and cards which are required. The amalgamation of typing and keypunching would increase the efficiency of the system by reducing personnel, space, and equipment requirements. The flow of material into the printed index would be accelerated through the elimination of backlog bottlenecks which the need for separate work stations creates.

*Auxiliary Card Decks.* The various decks of cards, other than those bearing the imprinted bibliographical citation and the secondary author cross reference entries which form an integral part of the system, require some comment here. These decks fall into two categories, those belonging to the subject heading framework and those which are a part of the Listomatic program deck; both comprise sizeable quantities of cards.

The subject framework of the *Index Medicus* consists of main headings, standard subheadings, and two types of cross references. These must appear in print in effectively differentiated type styles. Because the entire manuscript for the printer consists of film negative which has emerged from the Listomatic Camera, these subject elements must be imprinted on cards which may then be inserted in their proper locations in relation to the entries. Quantitatively this involves the provision of almost 5,000 main heading cards, 5,600 cross references and a virtually open ended number of subheadings which is now at a level of about 10,000 cards. The total number of these non-entry cards is thus in the neighborhood of 20,600. Since the Cumulation must be processed simultaneously with the regular January and February monthly issues, two complete sets of these cards must be on hand. Initial preparation of this mass of cards, and maintenance and replacement as a result of normal and abnormal wear are no small burden.

Finally, there is the Listomatic program deck, used in the collator to establish column lengths and insert page numbers and other publication necessities. Eight cards are needed for each page; since Volume 1 of the *Index Medicus* will comprise close to 5,000 pages, about 40,000 cards will be included in the entire Listomatic program deck. No additional cards, however, will be required for the cumulation.

#### PUBLICATION ASPECTS

The new format of the *Index Medicus* appears to have been received quite well. The use of the unit entry has eliminated the two-step shuttling back and forth from section to section, and users have generally expressed themselves pleased by this change. There are some users, however, who are now lamenting the demise of the Register of Articles. This reaction has been of great interest

because of the consistency with which this feature of the *Current List* served as a target for adverse criticism over the past decade.

Certain typographical improvements are planned for the second year. Various minor changes in type usage and leading of the non-entry elements will be initiated. The 31 per cent optical reduction selected for camera use has resulted in a type size for the entries somewhat smaller than had been sought, but other factors of the Listomatic design "package" required this sacrifice. Further experience by the printer with Listomatic copy will contribute appreciably to the overall appearance and ease of use of the *Index Medicus*.

\* \* \* \* \*

With the exception of the objective relating to the multiple and derivative exploitation of the index input (which will be discussed in the next chapter), the other major targets of the project have been described and appraised primarily from the viewpoint of the National Library of Medicine. The findings of the project as they are related to other potential applications are the topic of the concluding chapter of this report.

There remains one other dividend which has accrued to the Library, more intangible and less susceptible to measurement in monetary or temporal terms, which may well prove to be the greatest of the lot. The education and experience that was acquired as a result of the project will undoubtedly be put to good use in the years ahead. Through these efforts the NLM has received an impetus for further investigation of more sophisticated mechanization and automation techniques which will profoundly influence the Library's policies in the future.

## The Bibliographic Retrieval System

THE TWO FUNDAMENTAL characteristics of basic periodical indexes covering broad areas of the sciences are comprehensive listing and quick communication through prompt publication. A first gross sifting of the material under subject rubrics for information retrieval is all that is compatible, at the present stage of development, with these characteristics. The needs of more restricted subject fields may often require indexing a limited number of articles of proved worth at a greater depth than is feasible in the larger, more comprehensive index. Yet the limited index is often dependent to a great degree on the comprehensive index for the original discovery, scanning, and sorting of its material. It seemed desirable, therefore, to study means by which the limited index might make use of the work already accomplished by the comprehensive index, without needlessly and expensively retracing ground already covered.

One of the major shortcomings of the *Current List of Medical Literature* format was the inability to make wider use of its entries for other purposes. This was due primarily to the fragmentation of the bibliographic citation among the several sections of the publication, a situation which made total reconstitution of the elements of any sizeable number of citations a formidable task in itself. (Even such a simple device as the "Photoclerk" is difficult to employ under such circumstances.) The unit entry, though more space-consuming, may—because it is a self-contained entity—be duplicated and manipulated at will. The unit entry may be used many times over and reappear as a part of many different bibliographic products. As part of the project it was hoped to explore means of encoding unit-citation cards developed for the comprehensive index in order to make them immediately available for whatever limited indexes they might be desired (for example: cancer chemotherapy listing; cardiovascular drugs listing). The availability of large areas of the punched card for coding was an attractive incentive for attempting to utilize this space for a bibliographic retrieval system; the idea was that the subject codes punched into the cards as filing indicia for the publication system might also serve as search media for a retrieval system.

It was also believed that year of publication and language of publication would serve as useful additional search axes. This information was originally punched into each card. As hopes for successful development of a retrieval system waned

and finally vanished, this punching was abandoned. As these features do not bear on the main issue, no further mention of them is made.

The main fact to be borne in mind throughout the argument that follows is this: subject cards prepared for the publication system contain, as punched holes, only a numerical equivalent of the subject heading; *the identification of the item is solely in the clear text typed across the top of the card*. A subsidiary fact is that there is *only one subject code punched in each card*.

Mr. H. P. Luhn has used the terms *scanning* and *look-up* to distinguish procedures which involve searching an entire deck from those which involve the matching of numbered items in selected classes. The first procedure is *scanning*; the second, *look-up*.

*Scanning* may be outlined as follows:

1) A special deck of cards would have to be punched with multiple subject codes on each card. (Here the card becomes an item card, and the arrangement is by terms on items. Each card would also have to carry the clear text citation typed across the top to identify the item, or some substitute device such as a serial number would have to be used.)

2) The basic *Index Medicus* entry decks could not be used even if all subject codes were added to one of the subject cards of a single set (*i.e.*, even if one of the subject cards was punched to give the complete range of subjects for a particular item, thus constituting a master subject card), because selection by scanning would destroy the order of the deck and interfere with subsequent cumulation.

3) The only advantage which seems to be offered by a scanning system is reduction in the size of the file by creation of the necessary master card. For example, in the publication system an annual output of 150,000 items requires 450,000 subject cards if the average number of subjects per item is three; in five years, which is perhaps a minimal span for a retrieval system to cover, the number of subject cards involved would be 2,250,000. With the use of master cards, however, the five year file would contain only 750,000 cards. But the lower figure is still far too large for reasonable use in a scanning system. There are three machines available for scanning searches: the IBM Universal Card Scanner, the IBM 101, and the IBM 108. Of these, the IBM 108 with a rated speed of 1,000 cards per minute is the most rapid, but still it is obviously much too slow for a system adding 150,000 cards per year. A search of a five year file with the 108 would require 12.5 hours, plus handling time.

*Look-up*. A look-up system, rather than a scanning system, therefore seems necessary. A look-up system appears to offer many advantages, such as:

1) The look-up could be accomplished by use of the IBM 88 Collator (650 cards per minute from each feed), and with the Collator already a necessary element of the publication system, no additional expense for special machines would be required.

2) Collation would not require the extra effort of creating a special master subject deck, but could utilize the singly coded (singly headed) cards of the publication system.

3) The matching of a group of cards under a single subject rubric with a group of cards under another subject rubric would be rapid, accomplished in a few minutes plus handling time for the average single logical product.

4) The collating operation would not destroy the basic order of the cards, and replacement of the cards in publication order would not be a serious problem.

There is one flaw to the collating system. What would be matched? It must be remembered that in the publication system the item is not identified by any holes punched in the card, but only by the typed citation across the top. This means that to make the collating system possible each item would have to be numbered, and the item number would have to be punched into each subject card.

Because it is an item number that is needed, and because the same item number has to be assigned to all subject cards to which it pertains, the item number must be assigned at some early stage in the system, while the set of subject cards pertaining to a single item is still intact, and before it is dispersed. This points to the assignment of serial numbers to items at the time the data sheets leave the Index Assistant Station. Although several persons are working at this station, the problem could be solved, as it probably could not be at the point of input typing, or even at the entrance into the keypunch station, unless the flow were squeezed through a single additional process point for this purpose. In any event, the assignment of serial numbers would be random in respect to eventual location of the items in the printed index; item number 2 might appear under ZYGOMA, item 9887 under ABDOMEN, and item 5 under LUNG. Of course this would not matter; the serial numbers would appear as punches only, not in the typed entry, and not picked up on the printed page. The arrangement of items under each subject rubric, however, would have to be by ascending serial order, to permit subsequent retrieval collating; this would be in lieu of arrangement by rough alphabetization by author, which in the subject section serves no essential purpose and is of minimal usefulness. In cumulation, subsequent months' decks would have to follow previous months' decks, under each rubric, to preserve the ascending order of numbers; this would theoretically be of no moment, although it might happen that the completely random order of items resulting in a large cumulation printing might prove somewhat distressing even though the random order in a single month's issue could be tolerated.

The number of codes to be keypunched for the average item is, in the publication system, 4.5 (3 subjects and 1.5 authors). If a serial number is added, the number of codes to be keypunched rises to 5.5, an increase of almost 20 per cent in the keypunching load (the reproduction of serial numbers on second and third

subject cards of the same set could be handled automatically). The price in man-hours seems small enough.

(There is some wry humor in the realization of the fact that the old *Current List* numbered citation system would have been somewhat more amenable to a mechanical look-up retrieval system than is the new *Index Medicus* system.)

It was believed, however, that it was impractical to adopt the collating serially-numbered item system, for the following reasons:

1) The collator subjected the cards to smudging hazards, and this could not be tolerated because of subsequent cumulation publishing needs.

2) The blocks of subject group cards would have to be searched, in an enormous file, by hand, pulled by hand, and replaced by hand. The hazards of loss, mutilation, or disrupted order during the course of handling and transportation to and from the machine would be substantial; again, the integrity of the subsequent cumulation would be at stake.

3) More serious are certain defects of a system employing subheadings for a mechanical retrieval system; and more serious still is the judgment that, in the majority of special listings made with the system, the demanding of logical sums might be much more frequent than the demanding of logical products, and this would vitiate the entire rationale of the system. These points are discussed at greater length below.

The question of the subheading dilemma is an interesting one. The *Index Medicus* subject heading apparatus is of the co-ordinate indexing variety, *i.e.*, no single subject rubric precisely defines the subject of the article listed under it, but rather it is the conjunction of all subject headings assigned to the particular article which defines its true subject scope. In traditional library subject-heading practice, the juxtaposition of several words or phrases in a single heading, to obtain the maximum specificity desired, introduces severe problems of multiple entry for each of the several permutations of the grouping that are possible. Thus, for an article on "Streptomycin therapy of tuberculosis in infants", TUBERCULOSIS-STREPTOMYCIN-INFANTS might be used, but the fact has to be faced that five other permutations, each just as suitable, are possible.

In the *Index Medicus*, as in most library catalogs, the arrangement is that of items on terms, or more precisely, addresses (surrogates for the items) on terms. What has to be noted is that the address, the full bibliographic citation, is much more than an address. The article title, the authors' names, the journal title, and the date are in fact useful in defining more precisely the subject scope of the item.

What this means is that if the article on "Streptomycin therapy of tuberculosis in infants" is sought under the heading STREPTOMYCIN, one of the trio of terms that has been assigned, then that super-computer, the human mind, can easily make the co-ordination of ideas by simply examining the titles found there, without proceeding with the formalities of looking also under TUBERCULOSIS

and under INFANTS and making the exact co-ordination of all members of each group in order to find which members are common to all groups. Documentation theory has generally tended to gloss over this angle, which is a pity.

This is satisfactory for many purposes. It becomes less and less satisfactory as the size of the file grows. Any one of the three illustrative terms will have an enormous literature pertaining to it. It is a fairly painful experience to be confronted by half a dozen pages packed solid with material on TUBERCULOSIS, and to face the problem of picking out the specific item needed.

The traditional answer to this problem is "subdivision"; the word itself is a clue to the nature of the situation. Subdivision refers to the assignment of subheadings which will break up the large file under a main heading into manageable segments.

This immediately raises again the dilemma of permutations. It is costly to file a three-termed item in six places, or a four-termed item in twenty-four places; and it is costly to print this item so many times. Note here that the size of the expanded address, the full bibliographic citation rather than a simple serial number, begins to assume outsize proportions of its own.

Of the several remedies available, one is of major importance. This remedy consists of conventionalization or standardization of words or phrases used as subheadings, the restriction of these subheadings to a limited number, and the establishment in advance of a predetermined list of such subheadings, with rigid prescriptions for their use. If these constraints are accepted, as they must be, then one further implication follows. This is that a short, standardized, predetermined list of subheadings can afford to embrace only the very largest concepts. STREPTOMYCIN will not be a suitable standard subheading, whereas THERAPY may be. Using this approach, many quandaries of subject-heading assignment, of printing costs, and of search operations are mitigated.

This is the stage of practice which the *Index Medicus* exemplifies. It must be realized, however, that the problem has merely been mitigated, not solved. The amount of material to be found under TUBERCULOSIS-*therapy* is still enormous, and still growing rapidly. As the file grows, it becomes more and more desirable to compare compressed addresses rather than extended addresses, such as full bibliographic citations, through the use of sophisticated machines. It becomes more and more necessary to use the co-ordinate indexing principle in its pure state, without resort to subheadings. It is fair to say that in a co-ordinate indexing system, where the file is very large, and where machine operations are prominent, subheadings are irrelevant.

In other words, the printed traditional format of the *Index Medicus* is at odds with some fundamental principles of machine search. The situation is not completely hopeless, for it is susceptible to compromise. But the compromise will produce less effective results than may be reasonably desired.

The printed index is a necessity for a long time to come. Beyond this project, the problem will be to make the non-subheading machine style, used for special bibliographic demands, compatible with the style of the printed index. It would appear that the "standard subheading" feature of the printed index is likely to give way to a limited "pre-co-ordination" and combination of main headings, perhaps performed on a statistical basis.

The question of demanding logical sums is more interesting still. NLM conceived of the bibliographic retrieval system as involving categorical listings, that is, broad generic listings on topics at the level of body systems—CARDIOLOGY, ORTHOPEDICS—or of common diseases—DIABETES, TUBERCULOSIS. The system was not meant for day to day use in the answering of very specific and limited questions such as "Is there any record of the effect of morphine on paramecium?"

Now the preparation of such listings involves logical sums much more frequently than logical products. For the category DIABETES, for example, some 85 out of the 5,000 subject headings in the system might be considered pertinent. The preparation of a first-class listing from this array will involve sums, products, and complements, but it will involve sums predominantly.

To get the sum of all terms in any desired array, the collator could be used. All the terms in an array could be collated against the total entry deck. This procedure would require punching a deck for each array and collating against the total file. Certainly, selecting the blocks of cards under the relevant headings by hand would be much faster.

Arrays to which any heading belonged might be indicated by the indexer and properly coded. But since any heading might be a member of several arrays, indexing and coding of arrays would constitute a major operation added to the preparation of the *Index Medicus*, and would completely negate the by-product concept.

If only a single categorical listing is desired as an offshoot of the main publication system, the problem might be easily solved simply by inserting another station into the system, just prior to or following the Indexing Assistant. A single person could easily scan all the data sheets for material relevant to CARDIOLOGY and indicate that an extra card should be typed and thrown into a special bin, all without creating a serious bottleneck. It is when the one categorical listing multiplies into several and then into many that the real trouble would quickly begin.

Along this line of reasoning, it was the conclusion that a retrieval system could not be successfully grafted on to a publication system, which deals in large measure, within its mechanical aspects, with the problems of composition.

It appears that to achieve both ends, in the context of a very large system, it would be more suitable to start with the design of a retrieval system, and then

to proceed with the publication system as the subsequent and derivative problem. In a large system, this will probably require far more sophisticated machines than typewriters which are fed bits of tape piece by piece, and sorters which pass cards column by column at relatively slow speeds.

In April 1959, Dr. Robert S. Ledley of the George Washington University School of Engineering was engaged to "conduct a study to investigate the feasibility of using electronic digital computers for the publication of the *Index Medicus* and also as a basis for the construction of an efficient reference and bibliographic service." Dr. Ledley's investigation consists of the following phases:

- 1) A study of available computer equipment.
- 2) The development of flow charts based on the format of the new *Index Medicus*, and the recommendation of equipment that may be used in this context.
- 3) The calculation of processing requirements essential for schedule planning.
- 4) The preparation of detailed schedules for the preparation of the *Index Medicus*.
- 5) The analysis of relevant factors such as cost, time, and personnel requirements.

Dr. Ledley's final report is still in process and is, therefore, not yet available.

# Applications

THE DEVELOPMENT of a new system for publication of the *Index Medicus* has been described, and the results have been appraised. It remains to offer a general estimate of the possible application of the system in other situations.

In simplest terms, it may be convenient to think of the basic elements of the system as substitutes for the various elements of a conventional system, as follows: 1) the camera is a substitute for a manual shingling system, as in the preparation of the Library of Congress catalogs; 2) the stored file of imprinted cards in this cold-type system is comparable to the stored file of lead slugs in a hot-type system, as in the preparation of Wilson index cumulations; 3) the key-punch, sorter, and collator are substitutes for manual filing operations; 4) Justo-writers and their tapes are substitutes for hot typesetters and repetitive setting.

Certain basic ground rules become apparent:

1) The capital investment for equipment is fairly large; this indicates that the job embraced must be a large one if unit costs are to compare favorably with those of a manual system.

2) Unless there is a requirement for repetitive publication of the same material, or the bulk of the same material, the special features and strengths of the system are rendered largely meaningless and superfluous. In other words, unless cumulation of text or published revision of text is an important aim, the use of a high-speed step camera is difficult to justify. The one exception may occur in those instances where a large compilation is drawn up over a long period of time, and compression of end-time between completion of the compilation and publication is of extraordinary importance.

3) The nature of the "chunk" of material to be unitized on each card is important. Is it a single self-contained line? Is it a single line, not self-contained? Is it multiple line? Is it a variable number of lines? The answers to these questions have a large bearing on the choice of camera to be used.

4) Is the "chunk" of material to be repetitively listed in any single issue? If it is not, then the case for tape operated typewriters fails, and probably the case for right border justification also.

5) How severe are filing requirements? If close alphabetization of chunks, with indention and subindention of following chunks, in variable measure, is a requirement, then the punched card sorting and filing mechanisms are a boon.

If, on the other hand, the chunks are simply to be arranged in one long serial order, as for the non-self-contained lines of a narrative text, then special filing apparatus is not required.

It is instructive to note that the Listomatic camera was developed to solve composition problems of the Dun and Bradstreet directory. The camera has been used by the Philadelphia Real Estate Board for the listing of properties, and by General Motors and International Harvester in the preparation of supply catalogs. Recently the Chesapeake and Potomac Telephone Company has been employing the camera in the compilation of a telephone directory at Charleston, West Virginia. All of these uses have a common element—a body of material, a large part of which is relatively stable, but in the remainder of which there is constant erosion taking place, and a service requirement for up-to-date listings.

The Department of Defense, its bureaus and its contractors, have used the Foto-List and the Composo-List cameras with apparent success in the preparation of narrative material such as procedural manuals (as for the construction and equipment of battleships), wherein the changes in areas of the text are recurring and the need for publication of revised editions is imperative.

The Listomatic camera has been used for indexing purposes by the Atomic Energy Commission's Technical Information Service at Oak Ridge, Tennessee; by the National Research Council's Cardiovascular Literature Project, and by the National Library of Medicine. The uses in these three instances are widely disparate. It is fair to say that NLM use, with its auxiliary devices, is the most complex and most broadly integrated system of the lot.

The "service bureau" type of operation should not be overlooked. Originally the Merrywell Corporation of New York City offered such a Listomatic service; this company is now defunct. The Science Press of Lancaster, Pennsylvania, now offers this service. For occasional needs, this would appear to be the answer to what otherwise must be a heavy capital investment. What must be weighed are such factors as difficulty of transporting cards safely and expeditiously, and loss of control over and possibly effective integration of some elements of the total composition system.

#### REFERENCES

- SHOEMAKER, RICHARD H. Some American twentieth century book catalogs. *Lib. Resources and Tech. Services* 4: 195-207, Summer 1960.
- DAY, MELVIN S., AND LEBOW, IRVING. New indexing pattern for *Nuclear Science Abstracts*. *Am. Doc.* 11: 120-127, April 1960.







